PRELIMINARY DRAFT

# MONTANA STATEWIDE 208 SURFACE AND GROUND-WATER QUALITY ASSESSMENT AND MANAGEMENT ALTERNATIVES



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Sciences, Water Quality Bureau, Helena, Montana

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## ABBREVIATIONS

Ag-NPS--agriculture nonpoint source
APO--areawide planning organization
BDR--Boulder River below Boulder
BHES--Board of Health and Environmental Sciences
BHR--Big Hole River near Twin Bridges
BLC--Board of Land Commissioners
BLM--Bureau of Land Management
BMP--Best Management Practice
BNRC--Board of Natural Resources and Conservation
BOD--biochemical oxygen demand
BVR-Beaverhead River at Twin Bridges
CFD-Clark Fork River at Deer Lodge
COD--chemical oxygen demand
DCA--Department of Community Affairs
DHES--Department of Health and Environmental Sciences
DNRC--Department of Natural Resources and Conservation
DSL--Department of State Lands
EGR--East Gallatin River
F&G--Department of Fish and Game
FY--fiscal year
GRC--Grasshopper Creek near mouth
JER--Jefferson River near Three Forks
MACD--Montana Association of Conservation Districts
MAR--Madison River station
MCD--Muddy Creek near Dell
MDT--Minimum Dilution Time
mgd--million gallons per day
MMBF--million board feet
MPDES--Montana Pollutant Discharge Elimination System
MWPCA--Montana Water Pollution Control Act
MWQRS--Montana Water Quality Records System
NACD--National Association of Conservation Districts
NPS--nonpoint source
PPE--Prickly Pear Creek at East Helena
PPL--Prickly Pear Creek near Helena
RCM--Revised Code of Montana
RRR--Red Rock River above Lima Reservoir
RUR--Ruby River at Twin Bridges
SAR--sodium adsorption ratio
SBC--Silver Bow Creek below Warm Springs ponds
SCS--Soil Conservation Service
SHC--Sheep Creek above Muddy Creek
TDS--total dissolved solids
USFS--United States Forest Service
USGS--United States Geological Survey
WFM--West Fork Madison River near mouth
WGR--West Gallatin River at Central Park
WQB--Water Quality Bureau

## FOREWARD

The following draft report contains and assessment of surface and ground-water quality conditions in the Statewide 208 area and lists alternative management actions which could be implemented to deal with the major water quality problems.

As a preliminary draft, the report is subject to change based on public comment. Please submit suggestions and opinions to:

Statewide 208 Project<br>
Water Quality Bureau, DHES<br>
Capitol Station<br>
Helena, Montana 59601

Comments must be received by this office no later than February 1, 1979, if they are to be considered in the final Statewide 208 report and recommended plan.

## INTRODUCTION

The Water Quality Bureau's 1976, 305(b) report and 1977 Program Plan estimated 3,995 stream miles were being adversely impacted by nonpoint sources. These two reports also stated that point sources were or would soon be essentially under control.

The various nonpoint source assessments and technical studies undertaken through the Statewide 208 project have identified numerous specific problem segments not previously identified in the WQB's basin plans. At first glance, these new studies make it appear that Montana's NPS pollution problems are much more abundant than originally thought and that very little in the way of correcting or preventing problems has been accomplished in the past few years.

The person reading the following report should bear these points in mind:

1) The Statewide 208 project has done much to more specifically locate problems. For example, past studies have indicated the Clark Fork drainage has extensive mining problems; the 208 assessments have identified particular stream segments being adversely impacted by mining activities. Thus, the 208 project has not shown water quality problems to be more extensive than previously expected but it has more specifically identified water quality problems.

2) Not only is the treatment of nonpoint source problems different than that of point source problems, i.e., land management vs. end-of-pipe treatment, but the extent of the prevention and mitigation of nonpoint source problems is frequently not measurable. Thus, many improvements to Montana's water quality by elimination of nonpoint source problems have not and may never be quantitatively documented.

## PROJECT DESCRIPTION

### AUTHORIZATION

The Montana Statewide 208 Water Quality Management Planning project, described herein, was conducted with a grant from the United States Environmental Protection Agency. The Water Quality Bureau, Department of Health and Environmental Sciences, was designated by Governor Thomas Judge as the Statewide 208 planning agency authorized to receive funds under Section 208 (a)(b) of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500).

## OBJECTIVES

Principal objectives of the Statewide 208 planning process included:

1) Development of a water quality management plan to achieve the 1983 national goals of "water quality which provides for protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water by July 1, 1983;" and "the discharge of pollutants into the navigable waters be eliminated by 1985;"

2) Placement of planning emphasis on nonpoint source pollution which may be the greatest single barrier to attaining the 1983-1985 goals in Montana;

3) Development of a preservation philosophy and strategy to maintain the quality of waters currently meeting or exceeding the 1983-85 goals and the state's water quality standards.

## SCOPE

Statewide 208 planning was limited in scope by fund availability and time. Since the project area covers approximately 107,000 square miles (73 percent of the state's total) and contains about 500,000 people (65 percent of the state's total), in-depth, site-specific studies were limited to a few critical areas and high priority problems.

Identification of water quality problems in the remainder of the study area relied on existing data. As a result, there are still several drainages in the study area and some problems, such as ground-water pollution, which need further quantification. The report contained herein, in addition to outlining management programs for identified problems, will also identify additional assessments for the next year.

## STUDY AREA DESCRIPTION

### Physical Description

The 1975 population of the Statewide 208 study area was estimated to be 467,941 (does not include those counties wholly or partially within the designated 208 project areas). Study area population is expected to reach 540,300 by the year 2000; population projections for the study area are contained in Table 1.

Eastern Montana is mostly rural with large population centers being located along the Yellowstone and Missouri Rivers. Dryland farming and cattle ranching provide most of the economic support for this part of the state, but continued development and expansion of coal mining is expected to play an increasingly important role in the economy.

The majority of Montana's population lives in the western part of the state. Major industries there include mining, logging, and tourism. Climate of the study area is as variable as the topography. The Continental Divide and variations in elevation significantly influence

TABLE 1

COUNTY AND INCORPORATED CITY AND TOWN PROJECTIONS FOR THE MONTANA STATEWIDE 208 STUDY AREA

| | 1980 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|
| BEAVERHEAD COUNTY | 8,200 | 8,200 | 8,200 | 8,200 | 8,300 |
| Dillon | 4,600 | 4,600 | 4,600 | 4,600 | 4,650 |
| Lima | 350 | 350 | 350 | 350 | 350 |
| BLAINE COUNTY | 6,700 | 6,600 | 6,500 | 6,500 | 6,400 |
| Chinook | 1,800 | 1,800 | 1,750 | 1,750 | 1,750 |
| Harlem | 1,150 | 1,150 | 1,100 | 1,100 | 1,100 |
| BROADWATER COUNTY | 3,100 | 3,100 | 3,100 | 3,100 | 3,100 |
| Townsend | 1,700 | 1,700 | 1,700 | 1,700 | 1,700 |
| CASCADE COUNTY | 85,600 | 89,000 | 93,000 | 97,300 | 101,400 |
| Belt | 700 | 700 | 750 | 800 | 800 |
| Cascade | 700 | 750 | 800 | 800 | 850 |
| Great Falls | 62,500 | 65,100 | 67,900 | 71,050 | 74,050 |
| Neihart | 100 | 100 | 100 | 100 | 100 |
| CHOTEAU COUNTY | 6,300 | 6,200 | 6,100 | 5,900 | 5,800 |
| Big Sandy | 800 | 800 | 800 | 750 | 750 |
| Fort Benton | 1,850 | 1,800 | 1,800 | 1,700 | 1,700 |
| Geraldine | 350 | 350 | 350 | 350 | 350 |
| DANIELS COUNTY | 3,100 | 2,900 | 3,700 | 3,600 | 3,400 |
| Flaxville | 200 | 200 | 250 | 200 | 200 |
| Scobey | 1,550 | 1,450 | 2,250 | 2,200 | 2,100 |
| DAWSON COUNTY | 11,200 | 11,200 | 11,200 | 11,400 | 11,600 |
| Glendive | 6,150 | 6,150 | 6,150 | 6,250 | 6,400 |
| Richey | 400 | 400 | 350 | 350 | 350 |
| DEER LODGE COUNTY | 13,500 | 13,300 | 13,000 | 12,700 | 12,400 |
| Anaconda | 8,550 | 8,450 | 8,250 | 8,050 | 7,850 |
| FERGUS COUNTY | 13,300 | 13,300 | 13,300 | 13,400 | 13,600 |
| Denton | 400 | 400 | 400 | 400 | 400 |
| Grass Range | 200 | 200 | 200 | 200 | 200 |

TABLE 1, Continued

| | 1980 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|
| Lewistown | 6,800 | 6,800 | 6,800 | 6,850 | 6,950 |
| Moore | 200 | 200 | 200 | 200 | 200 |
| Winifred | 200 | 200 | 200 | 200 | 200 |
| GARFIELD COUNTY | 1,800 | 1,800 | 1,800 | 1,700 | 1,600 |
| Jordan | 550 | 550 | 550 | 500 | 450 |
| GLACIER COUNTY | 11,200 | 11,300 | 11,600 | 11,900 | 12,100 |
| Browning | 1,800 | 1,800 | 1,850 | 1,900 | 1,950 |
| Cut Bank | 3,900 | 3,950 | 4,050 | 4,150 | 4,200 |
| GOLDEN VALLEY | 1,000 | 1,000 | 900 | 900 | 900 |
| Lavina | 200 | 200 | 150 | 150 | 150 |
| Ryegate | 300 | 300 | 250 | 250 | 250 |
| GRANITE COUNTY | 2,700 | 2,800 | 2,800 | 2,800 | 2,800 |
| Drummond | 500 | 500 | 500 | 500 | 500 |
| Philipsburg | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| HILL COUNTY | 18,200 | 18,700 | 19,200 | 19,800 | 20,300 |
| Havre | 11,100 | 11,400 | 11,750 | 12,100 | 12,400 |
| Hingham | 250 | 300 | 300 | 300 | 300 |
| JEFFERSON COUNTY | 7,300 | 8,000 | 8,200 | 9,400 | 10,200 |
| Boulder | 1,100 | 1,100 | 1,100 | 1,100 | 1,100 |
| Whitehall | 1,450 | 1,500 | 1,550 | 1,750 | 1,850 |
| JUDITH BASIN COUNTY | 2,700 | 2,600 | 2,400 | 2,300 | 2,200 |
| Hobson | 200 | 200 | 200 | 150 | 150 |
| Stanford | 500 | 500 | 450 | 450 | 400 |
| LEWIS AND CLARK COUNTY | 40,900 | 44,900 | 48,800 | 52,800 | 57,500 |
| East Helena | 2,050 | 2,250 | 2,400 | 2,600 | 2,850 |
| Helena | 27,500 | 30,200 | 32,800 | 35,500 | 38,650 |
| LIBERTY COUNTY | 2,500 | 2,400 | 2,300 | 2,300 | 2,200 |
| Chester | 1,000 | 950 | 900 | 900 | 850 |
| LINCOLN COUNTY | 17,900 | 18,100 | 18,300 | 18,600 | 17,500 |

TABLE 1, Continued

| | 1980 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|
| Eureka | 1,050 | 1,100 | 1,100 | 1,100 | 1,100 |
| Libby | 3,250 | 3,300 | 3,350 | 3,400 | 3,200 |
| Rexford | 150 | 150 | 150 | 150 | 150 |
| Troy | 1,100 | 1,100 | 1,100 | 1,150 | 1,050 |
| McCONE COUNTY | 2,600 | 2,600 | 2,500 | 2,400 | 2,300 |
| Circle | 1,050 | 1,050 | 1,050 | 1,000 | 950 |
| MADISON COUNTY | 5,700 | 5,800 | 5,800 | 5,700 | 5,700 |
| Sheridan | 750 | 750 | 750 | 750 | 750 |
| Twin Bridges | 750 | 750 | 750 | 750 | 750 |
| Virginia City | 200 | 200 | 200 | 200 | 200 |
| MEAGHER COUNTY | 2,300 | 2,300 | 2,300 | 2,300 | 2,300 |
| White Sulphur Springs | 1,400 | 1,400 | 1,400 | 1,400 | 1,400 |
| MINERAL COUNTY | 3,700 | 3,800 | 3,900 | 4,000 | 4,100 |
| Alberton | 500 | 500 | 550 | 550 | 550 |
| Superior | 1,100 | 1,100 | 1,150 | 1,150 | 1,200 |
| MISSOULA COUNTY | 69,500 | 74,100 | 78,300 | 83,600 | 89,000 |
| Missoula | 31,300 | 33,300 | 35,250 | 37,600 | 40,050 |
| MUSSELSHELL COUNTY | 4,400 | 4,600 | 4,600 | 4,600 | 4,600 |
| Melstone | 250 | 250 | 250 | 250 | 250 |
| Roundup | 2,400 | 2,500 | 2,500 | 2,500 | 2,500 |
| PARK COUNTY | 12,800 | 13,100 | 13,500 | 13,800 | 14,200 |
| Clyde Park | 300 | 300 | 300 | 300 | 350 |
| Livingston | 7,300 | 7,450 | 7,700 | 7,850 | 8,100 |
| PETROLEUM COUNTY | 700 | 600 | 600 | 500 | 500 |
| Winnett | 250 | 200 | 200 | 150 | 150 |
| PHILLIPS COUNTY | 5,500 | 5,300 | 5,200 | 5,200 | 5,100 |
| Dodson | 200 | 150 | 150 | 150 | 150 |
| Malta | 2,300 | 2,250 | 2,200 | 2,200 | 2,150 |
| Saco | 350 | 350 | 350 | 350 | 350 |
| PONDERA COUNTY | 7,100 | 7,000 | 6,800 | 6,700 | 6,600 |

TABLE 1, Continued

| | 1980 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|
| Conrad | 3,350 | 3,300 | 3,200 | 3,150 | 3,100 |
| Valier | 700 | 700 | 650 | 650 | 650 |
| POWELL COUNTY | 8,000 | 8,200 | 8,300 | 8,500 | 8,600 |
| Deer Lodge | 5,150 | 5,300 | 5,350 | 5,500 | 5,550 |
| PRAIRIE COUNTY | 1,800 | 1,800 | 1,700 | 1,700 | 1,600 |
| Terry | 900 | 900 | 850 | 850 | 800 |
| RAVALLI COUNTY | 20,500 | 21,400 | 22,700 | 23,800 | 25,000 |
| Darby | 550 | 550 | 550 | 550 | 550 |
| Hamilton | 3,350 | 3,500 | 3,800 | 3,900 | 4,150 |
| Stevensville | 1,300 | 1,350 | 1,450 | 1,500 | 1,600 |
| RICHLAND COUNTY | 10,400 | 10,300 | 10,200 | 10,100 | 10,000 |
| Fairview | 1,000 | 950 | 950 | 900 | 900 |
| Sidney | 4,850 | 4,800 | 4,800 | 4,750 | 4,700 |
| ROOSEVELT COUNTY | 10,700 | 10,900 | 11,100 | 11,300 | 11,500 |
| Bainville | 200 | 200 | 200 | 200 | 200 |
| Brockton | 400 | 400 | 400 | 400 | 450 |
| Culbertson | 850 | 850 | 900 | 900 | 900 |
| Froid | 300 | 300 | 300 | 300 | 300 |
| Poplar | 1,450 | 1,450 | 1,500 | 1,550 | 1,550 |
| Wolf Point | 3,650 | 3,700 | 3,750 | 3,850 | 3,900 |
| SHERIDAN COUNTY | 5,400 | 5,200 | 5,200 | 5,100 | 5,000 |
| Medicine Lake | 350 | 350 | 350 | 350 | 350 |
| Outlook | 100 | 100 | 100 | 100 | 100 |
| Plentywood | 2,300 | 2,200 | 2,200 | 2,150 | 2,150 |
| Westby | 250 | 250 | 250 | 250 | 250 |
| SILVER BOW COUNTY | 40,900 | 40,700 | 40,500 | 40,500 | 40,500 |
| Butte | 22,950 | 22,850 | 22,750 | 22,750 | 22,750 |
| Walkerville | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| TETON COUNTY | 6,300 | 6,300 | 6,200 | 6,100 | 6,100 |
| Choteau | 1,650 | 1,650 | 1,650 | 1,600 | 1,600 |
| Dutton | 400 | 400 | 400 | 400 | 400 |
| Fairfield | 650 | 650 | 650 | 650 | 650 |

TABLE 1, Continued

| | 1980 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|
| TOOLE COUNTY | 5,300 | 5,400 | 5,400 | 5,500 | 5,500 |
| Kevin | 200 | 200 | 200 | 200 | 200 |
| Shelby | 2,900 | 2,950 | 2,950 | 3,000 | 3,000 |
| Sunburst | 550 | 550 | 550 | 550 | 550 |
| VALLEY COUNTY | 13,300 | 13,100 | 13,000 | 12,900 | 12,900 |
| Glasgow | 5,400 | 5,300 | 5,250 | 5,200 | 5,200 |
| Nashua | 600 | 600 | 600 | 600 | 600 |
| Opheim | 350 | 350 | 350 | 350 | 350 |
| WHEATLAND COUNTY | 2,500 | 2,500 | 2,500 | 2,400 | 2,400 |
| Harlowton | 1,350 | 1,350 | 1,350 | 1,300 | 1,300 |
| Judith Gap | 150 | 150 | 150 | 150 | 150 |
| WIBAUX COUNTY | 1,500 | 1,500 | 1,500 | 1,400 | 1,300 |
| Wibaux | 650 | 650 | 650 | 600 | 600 |

the area's climate. East of the Divide, winters are colder and summers hotter and drier than in the mountainous area west of the Divide with its modified North Pacific Coast type weather.

The study area is part of two physiographic provinces, the Northern Rocky Mountain province and the Missouri Plateau section of the Great Plains. The latter section can be further subdivided into glaciated and unglaciated sections. The western third of the Statewide 208 project area falls into the Rocky Mountain section. Several north-south trending mountain ranges occur in the northwest corner. Eastward are the frontal ranges of the Northern Rockies. Rocks in the area are of the Paleozoic and Mesozoic Age while rocks to the west are Precambrian. Eastward of the front ranges are the Big and Little Belt Mountains, topographically low compared to the western mountains. The Belts are anticlinal uplifts with Precambrian batholithic caves and Paleozoic and Mesozoic sedimentary rocks on their flanks.

Southwestern Montana contains many short mountain ranges and intermountain basins which are structural rather than erosional in origin. Many of the ranges are covered by Precambrian rocks and intermountain basins are filled with sediment deposited from Eocene to recent times.

The far eastern part of the study area, the Great Plains, is characterized by more subdued topography and composed of nearly horizontal, relatively undisturbed sedimentary rocks. The glaciated Missouri Plateau occurs north of the Missouri River. South of the Missouri River, much of the landscape is characterized by badland topography formed in the Tertiary and Cretaceous rocks. The Tertiary Fort Union Formation is a wide band running north-south in the far eastern portion of the study area.

Standing above the topography of the Great Plains are several mountain ranges which are outliers of the Rocky Mountains. These ranges include the Bear Paws, Highwoods, Judiths, Moccasins, Snowey's, Little Rockies, and Sweetgrass Hills.

The Statewide 208 study area is a headwaters area for several large river systems flowing from both sides of the Continental Divide and north to Hudson Bay. The Missouri River is the largest river and heads in the southwest corner at the confluence of the Madison, Jefferson, and Gallatin Rivers. The Missouri River flows northward, then eastward across the plains. South of the Missouri River is the Yellowstone River with headwaters in Wyoming. The river flows northeast and occurs in the Statewide 208 study area during its passage through Park, Prairie, Dawson, and Richland Counties. Major tributaries of the Yellowstone include the Big Horn, Tongue, and Powder Rivers. West of the Continental Divide, the Clark Fork of the Columbia River heads in the Butte-Anaconda area and flows into Idaho. A major tributary of the Clark Fork River is the Bitterroot River. In the northwest portion of the project area, the Kootenai River flows toward Canada. Also, a small area on the east side of the Divide, near Glacier Park, is drained by the St. Mary River which flows to Canada and the Hudson Bay.

General Water Quality Problem Description

Compared nationally, Montana has some of the United States' highest quality waters. In particular, some of the mountain headwater streams support excellent trout fisheries. However, nonpoint source pollution and excessive dewatering are significant problems in Montana. The Water Quality Bureau's 1976, 305(b) report estimated 3,995 stream miles were being degraded by nonpoint source pollution and dewatering. Of these segments, 2,512 miles were estimated to be degraded by sediment, dewatering was estimated to adversely affect 860 miles, and 1,400 miles were being degraded by salinity. Natural processes contribute to these problems; however, numerous human activities are responsible for a great portion. Logging, mining, urban and rural development, construction and in particular, agriculture are the major nonpoint source polluters and dewaterers in the Statewide 208 study area.

Presently, nonpoint source pollution and dewatering are localized, but continuing development of the state's natural resources poses a significant threat to all surface and ground waters.

RELATIONSHIP OF 208 TO WATER QUALITY BUREAU PROGRAM POLICY

Objectives and philosophies of the Water Quality Bureau's Program are the result of the state's Water Pollution Control Act which states in part:

1) It is the public policy of this state to:

   a) conserve water by protecting, maintaining, and improving the quality and potability of water for public water supplies, wildlife, fish and aquatic life, agriculture, industry, recreation, and other beneficial uses;

   b) provide a comprehensive program for the prevention, abatement, and control of water pollution.

The Montana Water Quality Standards are an administrative rule adopted by the Board of Health for the purpose of meeting responsibilities dictated by the Water Pollution Control Act. The Water Quality Standards contain water use classifications for all of Montana's classification. Water quality criteria define the minimum quality conditions and waste treatment requirements needed to protect, maintain, and improve the quality of potability of the state's surface waters.

From its inception, the state's water quality control program has been mitigative in nature and has focused almost entirely on point source pollution, i.e., municipal and industrial discharges. This emphasis on point source pollution seems questionable in a relatively non-industrial, non-urbanized state; however, from a nationwide perspective, a major portion of the water quality problems are the result of cities and industries. This national emphasis was carried down to the state level. In addition, a majority of the public health problems associated with water are caused by point source discharges.

The point source control philosophy is exemplified in the Montana Pollutant Discharge Elimination System (MPDES) which authorizes and controls point source discharges to state waters by means of a permit system. The permits regulate the quality, quantity, and duration of waste discharges.

Primarily as a result of the MPDES rule, the number of point source pollution problems have been dramatically reduced in the past few years. As of June, 1977, only an estimated 200 stream miles, out of approximately 4,000 miles being degraded, were being polluted by point source discharges and all of those 200 miles were expected to be corrected by construction measures in subsequent years.

Although the WQB's point source control program will virtually eliminate point source pollution, it has had little or no effect on nonpoint source pollution due mainly to funding constraints. Nationwide success of point source pollution control programs and passage of P.L. 92-500 have begun to focus attention of water quality management agencies on nonpoint source pollution and federal funds have been provided to states. Though these funds will facilitate correction of nonpoint source problems, integration of a comprehensive nonpoint source pollution control program is a few years away.

## RELATIONSHIP OF 208 TO OTHER PROGRAMS

Since water quality management planning is concerned with one major resource, water, and is directly affected by the use of another major resource, land, numerous local, state, and federal programs affect or are affected to some degree by 208 planning. Though continuous coordination of so many programs is a monumental task in itself, efficient use and protection of our natural resources demands that each planning agency at the least be aware of other applicable programs and ideally, actively participate in the most directly applicable planning processes. The Statewide 208 project has not succeeded in achieving the necessary degree of coordination with all other programs but has attempted to remain abreast of a few programs which most directly relate to water quality management planning. Those programs are discussed below.

Obviously, active integration of existing WQB programs with 208 planning was immediate. For example, it was not necessary for the Statewide 208 project to initiate facility planning, water quality monitoring, and a waste discharge permit program; these programs were already in existence within the WQB and the Statewide 208 project has used the programs with, in some cases, only slight priority modifications.

Within the Department of Health and Environmental Sciences, three other bureaus have programs with some degree of relationship to 208 planning. Subdivisions are subject to review by the Subdivision Bureau for public health considerations if facilities requiring water supply and sewage disposal are proposed. The WQB attempts to be aware of at least the larger proposed subdivisions as construction activities and subsurface disposal can have severe impacts on both surface and ground-water supplies.

The Water Quality Bureau also periodically reviews control practices recommended by the Solid Waste Bureau for land disposal sites. Poorly planned placement and operation of sites can again severely degrade ground and surface waters.

And, state air quality plans are reviewed periodically for possible conflicts with the water quality management objectives. Though the relationship between air and water quality is a bit obscure in most of Montana, reciprocal impacts are apparent in some of the more heavily populated and/or industrialized areas. For example, water quality can be directly affected by air quality, in particular, fall-out of heavy metals in Anaconda. Conversely, air quality can be affected by stormwater runoff pollution control measures such as frequent street sweeping.

The relationship of the designated 208 area planning programs to the Statewide 208 program is obvious since the WQB is responsible for review and approval of APO plans, coordination of the two programs has been continuous and will result in a well coordinated final product for the state.

Compatibility of objectives of the Statewide Sediment Control Project and 208 planning have warranted a continuous relationship between the projects. The Sediment Project is intended to identify the nature and extent of sediment pollution in Montana and to implement a management program. Since sediment pollution is a Statewide 208 priority, the two projects have worked closely in an inventory of the problems and development of a pilot control program.

Level B basin plans are reconnaissance-level evaluations of water and land resources for the purposes of recommending action plans and programs for the management of these resources. In the past, direct input of the WQB into Level B plans has consisted mostly of a review of the final reports. This lack of an active relationship between water quantity and quality planning is unfortunate in view of the ever-occurring conflicts between water use and water quality in Montana. However, attempts to increase the coordination have been made in the recently initiated Upper Missouri Level B study. Since that study area is contained entirely within the Statewide 208 study area, the WQB will attempt to be actively involved and express water quality concerns through the ad hoc groups, study team, and management board. Hopefully, this participation will insure that water quality is considered in planning for the use of Upper Missouri River water.

The various local, state, and federal land use-related planning programs are, by sheer number, the most difficult with which to maintain coordination. These consist of programs of Conservation Districts, county planning boards, Department of State Lands, Department of Community Affairs, Department of Natural Resources and Conservation, Department of Fish and Game, Department of Highways, Soil Conservation Service, Agriculture Stabilization and Conservation Service, U. S. Forest Service, Bureau of Land Management, Bureau of Reclamation, U. S. Fish and Wildlife Service, and U. S. Corps of Engineers to name a few. The WQB simply does not have

the people and time required to completely maintain active contact with each of these planning processes. At least, the WQB has attempted to make other agencies aware of its management responsibilities and hopefully, those responsibilities will be considered in other planning programs. Likewise, the WQB strives for the same consideration of other management programs and responsibilities.

## WATER QUALITY ASSESSMENT

The Statewide 208 water quality assessment relied, for the most part, on existing information. However, it became quickly apparent that nonpoint source problems were extensive and complex and sufficient data did not exist to adequately address them. Thus, early in the effort, a few specilized projects were initiated to obtain new data. Basically then, the assessment consisted of the following seven major efforts:

1) Computerized data compilation and evaluation
2) Land use inventory
3) Population projections
4) Fishery resource inventory
5) Individual nonpoint source surface and ground-water assessments
6) Specific technical studies
7) Point source evaluation

The assessment was then the basis for prioritization of problems and development of management alternatives.

### COMPUTERIZED DATA COMPILATION AND EVALUATION

The data handling system developed and being implemented for the Statewide 208 Program is the Montana Water Quality Records System (MWQRS). This is a computer-based system for entering, maintaining, and retrieving records of water quality information. The system was originally designed by the Research and Information Systems Division of the Montana Department of Community Affairs under a contract with the United States Geological Survey. Cooperating in the design were the Department of Health and Environmental Sciences, Water Quality Bureau, and the Montana Bureau of Mines and Geology. MWQRS utilizes the Mark IV File Management System developed and marketed by Informatics, Inc. This system is a software package which allows storage, updating, and retrieval of water quality data to be made with relative ease. The WQB is continuing to store all available water quality data in the system and has begun to recall data by various parameters as part of the evaluation process. The storage and evaluation will continue in the next year.

## LAND USE INVENTORY

The land use inventory and mapping effort, being conducted by the Montana Department of Community Affairs, Planning Division (DCA) is expected to be completed in late 1979. To initiate the inventory the WQB submitted a list of priority counties to DCA; final printed or at least work maps have been completed for those counties which include:

1. Lewis & Clark
2. Cascade
3. Teton
4. Hill
5. Blaine
6. Phillips
7. Valley
8. Missoula
9. Ravalli
10. Mineral
11. Silver Bow
12. Powell
13. Granite
14. Deer Lodge

The land use data and maps have, to a limited extent in the past few months, been used to identify possible water quality problem areas. A concentrated study of the Milk River and Clark Fork River Basins is anticipated for FY '79 and the land use information will be particularly valuable to those more detailed, specific efforts.

## POPULATION PROJECTIONS

Population projections for the Statewide 208 study area were derived by the Montana Department of Community Affairs, Research and Information Systems Division; their report by Phil Brooks details methodology used to derive those projections. The projections were listed in a previous section of this report. A major, practical use of the projections is in municipal point source management. The WQB's facility planning priority list (discussed in a later section) is based in part on those projections.

## FISHERY RESOURCE INVENTORY

In view of the Clean Water Act's emphasis on the biological integrity of streams, the Department of Fish and Game's (F & G) continuing effort to categorize fishery value of streams in Montana has served to satisfy a major objective of the Statewide 208 project.

One of the Department's initial classification systems, "the Blue Ribbon System," placed 8,813 stream miles in one of four classes based on their value as a fishery resource. Class 1, Blue Ribbon streams, were those streams of state and national value. Blue Ribbon segments totalled 452 miles and included portions of the Big Hole, Flathead, Madison, Missouri, West Gallatin and Yellowstone Rivers and Rock Creek. A total of 989 miles were ranked as Class 2, streams of statewide value; 2,412 miles were rated as Class 3, having value to large districts of the state; 4,960 miles were considered to be Class 4, having restricted local value. The Blue Ribbons system is somewhat subjective and in an attempt to use fisheries data to more accurately classify the fishery resource value of streams in Montana, F & G in cooperation with the U. S. Forest Service, designed a Fishery Data Input Form to compile and organize all existing fisheries data. Recognizing the data's importance to water quality management, the Statewide 208 project provided financial support for development of the computer storage/handling system.

Data entered into the system included:

1) Identification--stream name, state code, National Watershed Number, reach number, and boundaries

2) Resource value--ratings from 1 to 4 as follows:

   (a) Highest valued fishery resource

   (b) High-priority fishery resource

   (c) Substantial fishery resource

   (d) Limited fishery resource

3) Administrative locations

4) Ingress--describes types of legal rights to enter

5) Peak water temperature reached in an average summer

6) Indication of presence of spring creek defined as having fairly constant temperature and flow and clean water

7) Indication as to whether or not water temperature, flow pattern, and/or fish food are significantly affected by a lake or impoundment or if a downstream lake or reservoir results in fish runs into a reach or there is an ice problem in a reach.

8) Special value--used to show value of a reach which does not have significant game or sport fish population

9) Fish population--type, abundance, and fish's use of reach. Number of catchable size game and sport fish is recorded when available.

10) Habitat trends--indicated as improving, deteriorating or static

11) Esthetics--a code number from 1(poorest) to 5 (best)

12) Entries made for a variety of natural and man-caused limiting factors including man-caused pollution.

The survey effort has covered all major streams (1,457) having significant fishery values; these segments total 22,386 kilometers. Future efforts will be devoted to compiling data on second priority streams and breaking down the initial segments into reaches. This latter effort will facilitate a more accurate location of specific problems. As the data now read, each stream segment was examined for particular problems; however, not every kilometer recorded is affected by a particular problem. For example, a 20.6 km segment of the Beaverhead River was reported as having mining-related problems; somewhere within the 20.6 km segment mining impacts are

occurring but not every kilometer of the segment may be adversely affected. Man-caused pollution problems as identified in the inventory will be discussed in applicable sections of this report.

In addition to becoming more detailed and refined in the next year, the F & G inventory will be the basis for maps designed to depict the fishery resource value of all streams in the state. The WQB will continue to use the data to identify site-specific nonpoint source problems.

## INDIVIDUAL NONPOINT SOURCE SURFACE AND GROUND-WATER ASSESSMENTS

Nonpoint source problems have been the major focus of the Statewide 208 project. The individual assessments, discussed in this section, have significantly added to our knowledge of the nature and extent of Montana's most difficult water quality problems; however, the assessments have also shown the need for additional assessments to more accurately identify nonpoint problems and causes. As a function of the elements and man's seasonally changing land use patterns, nonpoint source problems are more difficult to document. Thus, the Statewide 208 project has really just "scratched the surface" of awareness regarding nonpoint source problems, but it has been a significant first achievement necessary for development of a successful nonpoint source management program for Montana.

### Surface Water

Agriculture--Agricultural land use has long been considered to be Montana's most critical nonpoint source pollution problem. Prior to 208 planning, this assumption was based on the facts that many streams were suffering from sediment pollution, agriculture was accounting for 82 percent of the land use in the state, and on about 57 percent of the agriculture acres, soil erosion was identified as the dominant problem (Conservation Needs Inventory, 1970). Thus, early in the Statewide 208 planning process, Ag-NPS pollution was selected as the project's highest priority. Even though the WQB was convinced an active land conservation program would significantly improve Montana's water quality, the extent of agricultural-related water quality problems which could feasibly be corrected remained to be ascertained.

Early in the Statewide 208 program a contract was developed with the Montana Association of Conservation Districts (MACD) for an assessment of agriculture nonpoint source problems. The first step of that assessment was development of a questionnaire to identify areas where agricultural activities were known or suspected to be causing water quality degradation. The Statewide Sediment Control Project, MACD, and the WQB worked cooperatively to revise the Sediment Project questionanire to cover streambank erosion, salinity, and confined feeding operations. The questionnaires were then distributed to each district in the Statewide 208 study area for completion. The information was compiled and mapped by subdrainage basin as delineated by the USGS Hydrologic Unit Map, 1974. Figure 1 identifies basins in the study area; Figure 2 (map pocket) is a depiction of the Districts' data. MACD hired an individual consultant to summarize and analyze Districts' data; the following discussion is based on that consultant's report (Hehn, 1978).

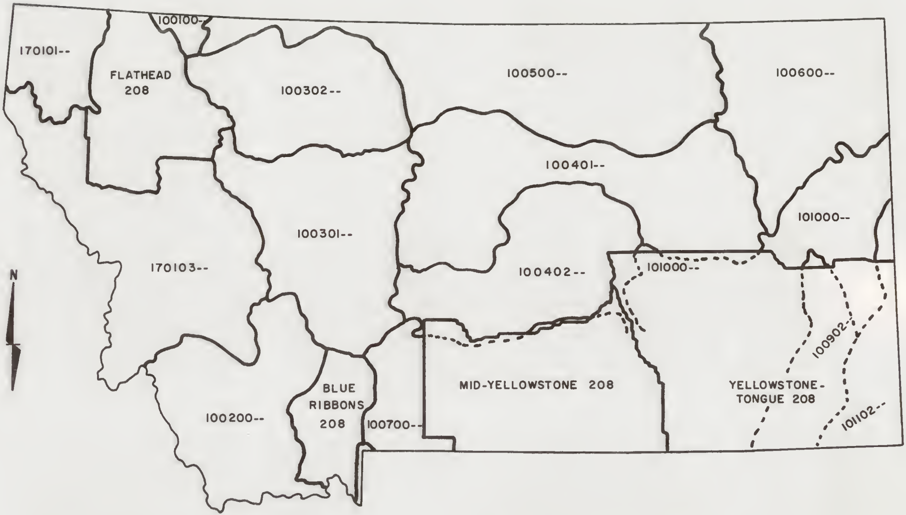


Figure 1. Basin delineations used in Conservation District inventory.

The Statewide 208 study area covers 60,880,091 acres. Table 2 shows the acreage totals for each major drainage basin. The conservation districts estimated about 72 percent of the project area, 43,797,138 acreas, is being used for agricultural purposes. Rangeland and pasture make up about 71 percent of the agriculture land; the remainder is classed as dry or irrigated cropland.

Viewed geographically, a majority (about 82 percent) of the agricultural land is in the Great Plains area east of the Continental Divide. Data from the district survey also indicate only about 14 percent of land west of the Continental Divide (Kootenai and Clark Fork Basins) is used for agricultural purposes while 85 percent of the plains area (remaining basins) is devoted to agricultural use.

sediment-water erosion--Tables 3-5 show acreages for each major agricultural land use and the degree of soil erosion in each basin as reported by the Conservation Districts. The majority of soil erosion by water occurs on dry cropland. Thirty-four percent of the dry cropland in the Statewide 208 study area (3,667,225 acres) is experiencing some degree of water erosion. About 16 percent (4,870,591 acres) of rangeland pasture has some degree of soil loss by water. Only 8 percent (144,403 acres) of the irrigated acres are experiencing water erosion.

Depending on the way in which the Conservation District data are compiled, apparent impacts of agriculture-related soil erosion on water quality is significantly changed. For example, the fact that the Districts estimate soil is being removed by water from 8,682,219 acres in the Statewide 208 study area is, in itself, dramatic; however, that figure cannot be used alone to describe water quality impacts due to water erosion. That acreage represents only about 15 percent of the study area and only about nine percent of the entire state. Also, the figure obviously does not indicate the length of time those acres are eroding, how much soil is being removed, and most importantly, how much of the lost soil is actually entering water bodies to the detriment of their quality. The most that can be said of Ag-NPS sediment pollution from the Districts' data is that the potential for detrimental impact due to water erosion in the Statewide 208 study area is significant.

The Fish and Game survey has identified sements that, from a fishery standpoint, are being degraded by sediment, Irrigation-related pollution, including silt, is affecting some portion of 87 segments, the length of which total 2,761.5 km.

sediment-streambank erosion--Table 6 summarizes the Districts' data on streambank erosion. Thirty-two percent of all streambank erosion was considered to be natural. Of the man-related activities considered to cause streambank erosion, grazing affected the most miles. Most of the grazing-impacted streams are expected to occur in smaller pastures located close to ranch headquarters and subjected to year-around use or are those used for concentrated winter feeding.

TABLE 2

DRAINAGE BASIN ACREAGES

CONSERVATION DISTRICT INVENTORY FOR THE STATEWIDE 208 AREA

| BASIN | USES NUMBER | TOTAL ACRES |
|---|---|---|
| Kootenai | 170101 | 2,299,400 |
| Clark Fork | 170102 | 8,724,249 |
| Jefferson | 100200 | 6,052,264 |
| Madison | 100200 | 250,364 |
| Upper Yellowstone | 100700 | 1,607,588 |
| Upper Missouri | 100301 | 6,595,110 |
| Marias | 100302 | 4,617,580 |
| Middle Missouri | 100401 | 8,585,710 |
| Musselshell | 100402 | 5,664,680 |
| Milk | 100500 | 8,347,020 |
| Lower Missouri | 100600 | 4,621,956 |
| Lower Yellowstone | 101000 | 3,204,770 |
| Lower Tongue | 100902 | 67,200 |
| Beaver | 101102 | 242,200 |
| | | 60,880,091 |

TABLE 3

WATER EROSION ON DRY CROPLAND

IN THE STATEWIDE 208 STUDY AREA

| BASIN | ACRES IN DRY CROPLAND & % OF BASIN TOTAL | ACRES WITH SLIGHT-SEVERE EROSION & % BASIN LANDUSE TOTAL |
|---|---|---|
| Kootenai | 6,820 (1%) | 20 (<1%) |
| Clark Fork | 79,827 (1%) | 19,220 (24%) |
| Jefferson | 77,832 (1%) | 13,185 (17%) |
| Madison | 2,500 (1%) | 50 (<1%) |
| Upper Yellowstone | 79,000 (5%) | 27,513 (35%) |
| Upper Missouri | 930,356 (14%) | 254,303 (27%) |
| Marias | 2,431,563 (53%) | 979,905 (40%) |
| Middle Missouri | 1,605,173 (19%) | 740,138 (46%) |
| Musselshell | 279,912 (5%) | 67,562 (24%) |
| Milk | 2,417,438 (29%) | 526,937 (22%) |
| Lower Missouri | 2,107,740 (46%) | 832,592 (40%) |
| Lower Yellowstone | 708,462 (22%) | 85,117 (12%) |
| Lower Tongue | 5,362 (8%) | 590 (11%) |
| Beaver | 149,330 (62%) | 120,093 (80%) |
| | 10,881,315 (18%) | 3,667,225 (34%) |

TABLE 4

WATER EROSION ON RANGELAND/PASTURE IN THE STATEWIDE 208 STUDY AREA

| BASIN | ACRES IN RANGELAND/PASTURE & % OF BASIN TOTAL | ACRES WITH SLIGHT-SEVERE EROSION & % OF BASIN LANDUSE TOTAL |
|---|---|---|
| Kootenai | 36,105 (71%) | 0 |
| Clark Fork | 1,160,092 (14%) | 185,966 (16%) |
| Jefferson | 3,573,303 (69%) | 1,069,670 (30%) |
| Madison | 147,561 (59%) | 120 (1%) |
| Upper Yellowstone | 662,243 (41%) | 62,130 (9%) |
| Upper Missouri | 3,375,191 (51%) | 531,341 (16%) |
| Marias | 1,539,719 (33%) | 456,702 (30%) |
| Middle Missouri | 5,906,085 (69%) | 1,101,868 (16%) |
| Musselshell | 4,558,454 (80%) | 775,547 (17%) |
| Milk | 5,394,178 (65%) | 259,683 (5%) |
| Lower Missouri | 2,343,350 (51%) | 257,284 (11%) |
| Lower Yellowstone | 2,248,722 (70%) | 152,719 (7%) |
| Lower Tongue | 60,415 (90%) | 604 (1%) |
| Beaver | 81,788 (34%) | 16,957 (21%) |
| | 31,087,206 (51%) | 4,870,591 (16%) |

TABLE 5

WATER EROSION ON IRRIGATED CROPLAND IN THE
STATEWIDE 208 STUDY AREA

| BASIN | ACRES IN IRRIGATED CROPLAND & % OF BASIN TOTAL | ACRES WITH SLIGHT-SEVERE EROSION & % OF BASIN LANDUSE TOTAL |
|---|---|---|
| Kootenai | 4,570 (<1%) | 40 (<1%) |
| Clark Fork | 209,369 (3%) | 28,249 (14%) |
| Jefferson | 657,519 (11%) | 9,691 (<2%) |
| Madison | 4,400 (1%) | 22 (<1%) |
| Upper Yellowstone | 61,622 (4%) | 4,580 (7%) |
| Upper Missouri | 322,724 (5%) | 42,410 (13%) |
| Marias | 192,789 (4%) | 27,492 (14%) |
| Middle Missouri | 56,075 (<1%) | 13,151 (23%) |
| Musselshell | 110,850 (2%) | 6,344 (6%) |
| Milk | 114,702 (1%) | 5,007 (4%) |
| Lower Missouri | 30,940 (<1%) | 1,303 (4%) |
| Lower Yellowstone | 62,462 (2%) | 6,099 (10%) |
| Lower Tongue | 295 (<1%) | 15 (5%) |
| Beaver | 300 (<1%) | 0 |
| | 1,828,617 (3%) | 144,403 (8%) |

TABLE 6

STREAMBANK EROSION IN THE STATEWIDE 208 STUDY AREA

| | Cause of Erosion | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Geologic | Modification | Construction (miles) | Logging | Grazing | Tillage | Mining | Other |
| Kootenai | 2 | 0 | 120 | 0 | 7 | 17 | 0 | 0 |
| Clark Fork | 118 | 0 | 28 | 193 | 55 | 11 | 11 | 18 |
| Jefferson | 57 | 2 | 2 | 18 | 116 | 7 | 5 | 0 |
| Madison | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Upper Yellowstone | 0 | 0 | 1 | 6 | 30 | 2 | 0 | 0 |
| Upper Missouri | 131 | 0 | 8 | 0 | 24 | 10 | 1 | 8 |
| Marias | 323 | 0 | 0 | 0 | 34 | 20 | 0 | 40 |
| Middle Missouri | 25 | 40 | 15 | 85 | 412 | 54 | 10 | 0 |
| Musselshell | 317 | 179 | 0 | 90 | 241 | 20 | 0 | 0 |
| Milk | 65 | 0 | 0 | 0 | 5 | 19 | 0 | 0 |
| Lower Missouri | 0 | 95 | 222 | 0 | 23 | 0 | 0 | 0 |
| Lower Yellowstone | 54 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Lower Tongue | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beaver | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1092(32%) | 316(9%) | 397(12%) | 392(12%) | 947(28%) | 161(5%) | 27(<1%) | 66(2%) |

The 179 miles of stream modification in the Musselshell Basin are the result of past railroad grade construction. Flow fluctuation as a result of operations of the Fort Peck Reservoir account for the 95 miles of erosion in the Lower Missouri Basin. Excluding natural erosion, the Middle Missouri and Musselshell Basins had the greatest number of miles of eroded streambanks. Considering the major land use in both basins is rangeland/ pasture, the extensive impact of grazing is not surprising.

The Montana Department of Fish and Game estimates there are approximately 16,000 miles of streams in the state; no accurate estimate has yet been made for the Statewide 208 study area. According to the Conservation District survey, grazing and tillage accounted for 1108 of the total miles affected by streambank erosion in the study area; that figure represents about seven percent of the state's total stream miles. The Fish and Game survey has identified stream segments with bank erosion problems. Channels of 100 segments have been altered for agricultural purposes. These segments amount to 2,258.2 km. In addition, bank encroachment, defined as a road, plowed field, etc., and bank deterioration due to agricultural activities have been identified in 96 segments (2,116.1 km.). However, the apparent slight impact does not preclude the fact that certain affected segments may warrant management consideration by virtue of a specific stream's relative statewide value.

This information must be considered to be fairly cursory as the question of streambank erosion is subject to interpretation and the Districts only reported the most obvious and critical problems. Additional district by district assessments will more accurately quantify the extent of streambank erosion.

sediment-wind erosion--Table 7 shows basin summaries for the degree of wind erosion. A total of 1,994,351 acres in the Statewide 208 area are affected by accelerated wind erosion. Of the total acreage affected, dry cropland accounted for 92 percent; but, those acres represent only 17 percent of the total dry cropland acreage in the Statewide 208 area. Of the rangeland/pasture acreages affected by wind erosion, the Middle Missouri River Basin had the greatest number. Other basins, such as the Musselshell and Milk, have nearly as much acreage in rangeland and pasture but were reported to have relatively little wind erosion.

Cropland wind erosion is an age-old problem; however, its significance as a source of water pollution is debatable. Obviously, soil that is being moved by wind action is ultimately deposited either on land or in water, but District data do not quantify actual water quality impacts. At any rate, the potential for aeolian deposition of sediment into water systems in the Statewide 208 area exists when approximately two million acres are losing topsoil.

salinity--Magnitude of salinity impacts are shown in Table 8 More acres of dry cropland are affected by salinity but the percentage of land affected is higher on irrigated cropland than in dry cropland (3.2 percent vs. 1.5 percent). Though total acreage affected by salinity (170,222 acres) represents only .28 percent of the project area, in those basins where the problem is most prevelant, affected acreage is increasing.

TABLE 7

WIND EROSION CONTRIBUTING TO SEDIMENT POLLUTION IN THE STATEWIDE 208 STUDY AREA

| | Acres of Wind Erosion & % of Basin Total | | |
|---|---|---|---|
| Basin | Rangeland/Pasture | Cropland | Other |
| Kootenai | 0 | 0 | 3,000 (78%) |
| Clark Fork | 2,969 (<1%) | 1,658 (<1%) | 6,224 (<1%) |
| Jefferson | 8,300 (<1%) | 20,970 (3%) | 2,215 (2%) |
| Madison | 0 | 250 (4%) | 20 (59%) |
| Upper Yellowstone | 0 | 1,200 (1%) | 0 |
| Upper Missouri | 9,190 (<1%) | 96,436 (10%) | 1,770 (1%) |
| Marias | 8,462 (<1%) | 610,429 (25%) | 36,312 (28%) |
| Middle Missouri | 59,750 (1%) | 157,723 (10%) | 225 (<1%) |
| Musselshell | 1,796 (<1%) | 35,978 (13%) | 1,600 (2%) |
| Milk | 5,877 (<1%) | 214,203 (9%) | 200 (<1%) |
| Lower Missouri | 20,020 (<1%) | 644,633 (31%) | 365 (<1%) |
| Lower Yellowstone | 20 (<1%) | 40,021 (6%) | 35 (<1%) |
| Lower Tongue | 0 | 0 | 0 |
| Beaver | 0 | 0 | 0 |
| | 116,384 (.2%) | 1,826,001 (3%) | 51,966 (.1%) |

TABLE 8

ACREAGE AFFECTED BY SALINITY IN THE STATEWIDE 208 STUDY AREA

| Basin | Irrigated Acres | Cropland Trend | Dry Acres | Cropland Trend |
|---|---|---|---|---|
| Kootenai | 0 | - | 0 | - |
| Clark Fork | 2,850 | same | 6,714 | same |
| Jefferson | 21,675 | same | 150 | same |
| Madison | 0 | - | 0 | - |
| Upper Yellowstone | 350 | same | 0 | - |
| Upper Missouri | 18,585 | variable | 26,860 | increase |
| Marias | 2,800 | increase | 20,929 | increase |
| Middle Missouri | 1,061 | variable | 37,619 | increase |
| Musselshell | 2,630 | increase | 12,682 | increase |
| Milk | 7,225 | increase | 14,960 | increase |
| Lower Missouri | 506 | variable | 37,230 | increase |
| Lower Yellowstone | 340 | variable | 3,271 | increase |
| Lower Tongue | 0 | - | 4,000 | increase |
| Beaver | 0 | - | 5 | same |
| | 58,022 | | 164,420 | |

Irrigation return flows and natural runoff from salt laden croplands have been estimated to degrade about 1400 miles of stream in the state (WQB, 1976). Though the Conservation District data do not quantify the number of stream miles being adversely impacted and though 200,000 acres appear to be statistically insignificant on a statewide basis, two facts make the problem particularly critical. First, the necessary long-term recovery rate needed for accumulated salts to be flushed out of the soil means a long-term impact on receiving waters; and second, the annual increase of saline seep magnifies the potential threat to surface water quality.

nutrients--Another agriculture-related water quality problem is nutrient runoff from confined feeding operations. The Conservation District survey was restricted to facilities used for extended periods of time and from which surface runoff entered a stream. This definition excludes winter feeding operations. Table 9 lists the basin figures. Although these facilities represent a potential threat to surface water quality in the area, the degree of impact is unknown and needs quantification. In addition, Hehn (1978) suggested that winter feeding areas should be included in an inventory of animal waste pollution sources. In some areas winter feeding in drainages is common and is unnecessarily polluting streams.

Excessive agricultural nutrients can also enter streams via irrigation return flows. The Fish and Game survey has identified 87 segments (2,761.5 km.) in the state which have significantly increased temperature, silt, and/or <u>nutrients</u> due to irrigation return flows.

land conversion--Even though agriculture-related pollution needs more analysis to better quantify its extent, the fact is obvious that it does represent a significantly potential water quality problem in the Statewide 208 area. Consequently, agriculture trends, and in particular, conversion of marginal rangeland to cropland is of interest because these lands are generally most susceptible to erosion.

The Districts were asked to estimate acres of rangeland converted to cropland since 1972, (Table 10). They were also asked to indicate how much of the land was being converted by use of Best Management Practices, how much of the converted land was Class IV-VI (land requiring specific limitations if it is to be used successfully for cropland), how much of the new cropland was being irrigated, and the source of the irrigation water. Most of the conversion is occurring in those basins where cropping is already extensive, i.e., Middle and Lower Missouri, Marias, and Milk Basins.

This plow-under of grassland is of concern to water quality management in the Statewide 208 area for several reasons. First, about half of the converted land is characterized as Class IV-VI. Class IV lands "have very severe limitations that restrict the choice of plants and require very careful management or both." Class V lands "have limitations that restrict normal tillage, and the choice of plants that can be grown. Lands are nearly level but wet, and may be frequently subject to flooding or ponding." Class VI lands "have continuing

TABLE 9

ANIMAL CONFINEMENT FACILITIES WHICH CONTRIBUTE
SURFACE RUNOFF TO RECEIVING STREAMS IN THE STATEWIDE 208 AREA

| Basin | Less than 300 animals | 300 to 1,000 animals | 1,000 or more animals |
|---|---|---|---|
| Kootenai | 0 | 0 | 0 |
| Clark Fork | 63 | 0 | 0 |
| Jefferson | 16 | 4 | 1 |
| Madison | 0 | 0 | 0 |
| Upper Yellowstone | 1 | 1 | 0 |
| Upper Missouri | 9 | 1 | 0 |
| Marias | 6 | 3 | 1 |
| Middle Missouri | 5 | 0 | 1 |
| Musselshell | 5 | 8 | 1 |
| Milk | 19 | 4 | 3 |
| Lower Missouri | 2 | 4 | 0 |
| Lower Yellowstone | 9 | 11 | 5 |
| Lower Tongue | 0 | 0 | 0 |
| Beaver | 0 | 0 | 0 |
| | 135 | 36 | 12 |

TABLE 10

SUMMARY OF LAND USE CHANGE FROM RANGELAND TO CROPLAND IN THE STATEWIDE 208 STUDY AREA SINCE 1972

| | Acres Converted (% of rangeland) | BMP's Applied (%) | Class IV-VI Land (%) | Acres Irrigated (%) | Water Source (%) Well | Water Source (%) Stream |
|---|---|---|---|---|---|---|
| Kootenai | 1,000 (3%) | 50 | 60 | 10 | 0 | 100 |
| Clark Fork | 9,181 (<1%) | 91 | 69 | 47 | 11 | 89 |
| Jefferson | 14,320 (<1%) | 82 | 32 | 92 | 2 | 80 |
| Madison | 200 (<1%) | 100 | 10 | 0 | - | - |
| Upper Yellowstone | 2,800(<1%) | 100 | 57 | 64 | 0 | 100 |
| Upper Missouri | 36,145 (>1%) | 67 | 34 | 35 | 36 | 64 |
| Marias | 96,640 (6%) | 54 | 51 | 3 | 0 | 93 |
| Middle Missouri | 140,147 (2%) | 47 | 46 | 1 | 2 | 96 |
| Musselshell | 56,753 (1%) | 50 | 59 | 8 | 1 | 92 |
| Milk | 144,821 (3%) | 65 | 26 | 3 | 0 | 100 |
| Lower Missouri | 86,683 (4%) | 34 | 72 | 1 | 0 | 100 |
| Lower Yellowstone | 45,522 (2%) | 25 | 73 | 2 | 0 | 71 |
| Lower Tongue | 3,000 (4%) | 50 | 80 | 0 | - | - |
| Beaver | 1,200 (2%) | 50 | 100 | 0 | - | - |
| | 639,412 | 51% | 48% | 7% | 2% | 90% |

limitations that cannot be corrected, such as; (1) steep slopes that have high erosion hazard, (2) shallow rooting zone, (3) stoniness, (4) excessive wetness overflow, (5) low moisture storage capacity, (6) high salinity or alkalinity---" (Conservation Needs Inventory, 1970). Thus, these lands have an inherent ability to produce sediment-laden and/or saline runoff unless they are handled with carefully designed management practices. And, as the districts indicated, better than half of the conversion are not using BMP's. In addition, when new cropland is plowed under, it is often in large blocks rather than strips, thus increasing the potential for wind erosion. And, irrigation of submarginal land facilitates leaching of salts to ground and surface waters.

Wheat prices of the 60's have stimulated conversion in eastern Montana. SCS estimated 250,000 acres were converted between 1967 and 1973 (Environmental Quality Council, 1976; Ross, et al., 1973). The Montana Crop and Livestock Reporting Service has collected data on the breakup in the past four years. Slightly more than one million acres have been converted in the state since July 1, 1974. The conversion peaked at 325,000 acres in 1975, and has been decreasing slightly. Continued conversion of acreage to marginal cropland underscores the need for creating an awareness of environmental capabilities and constraints if future water quality degradation is to be avoided.

Stormwater Runoff--The initial stormwater runoff assessment for the Statewide 208 area was restricted to a fairly in-depth treatment of all towns over 3,000 population, a mapping and cursory consideration of small towns with 100-3,000 people, and evaluation of impacts from a few selected, larger industrial sites. Selection of the 3,000 population cut-off was arbitrary; however, smaller towns in the area generally do not have extensively developed curb and gutter systems which are conducive to runoff and receiving streams are probably, in most cases, adequately assimilating any runoff. In addition, the population criterium resulted in a sample size adequate for assessment within budget and time constraints.

urban runoff--For larger towns, data on land use, storm sewer systems, precipitation, population density, and street sweeping frequency were obtained from questionnaires sent to city sanitarians. These data were used to determine pollutant loads for total suspended solids, five-day biochemical oxygen demand, phosphorus, and nitrogen.

A comparative relationship between suspended solids increase and turbidity violations was used to quantify the effect of pollutant loads on the quality of receiving streams. In each case, total number of hours needed to dilute stormwater and not exceed turbidity limits (Minimum Dilution Time, i.e., MDT) was calculated. For comparative purposes, if MDT exceeds 500 hours, turbidity violations can be expected and further field investigations are warranted. A detailed description of the models used in the assessment is contained in Brown and Garvin's (1977) report.

Table 11 summarizes the large town urban runoff assessment. Ten communities were apparently causing no critical stormwater runoff problems. The potential problems are discussed individually below.

TABLE 11

STORMWATER RUNOFF ASSESSMENT FOR LARGE TOWNS
IN THE STATEWIDE 208 STUDY AREA

| Town | Population | Receiving Stream | TSS* #/yr | Minimum Dilution Time (hours) |
|---|---|---|---|---|
| Anaconda | 9,771 | Warm Springs Creek | 112,904 | 834 |
| Butte | 23,368 | Blacktail Creek | 77,787 | 4,208 |
| Cut Bank | 4,004 | Cut Bank Creek | 93,388 | 1,818 |
| Deer Lodge | 4,306 | Clark Fork River | 4,259 | 8.87 |
| Dillon | 4,548 | Blacktail Deer Creek | 8,179 | 184 |
| Glasgow | 4,700 | Milk River | 45,676 | 504 |
| Glendive | 6,305 | Yellowstone River | 15,198 | 0.95 |
| Great Falls | 60,091 | Missouri River | 1,438,692 | 77 |
| Havre | 10,558 | Milk River | 113,629 | 1,077 |
| Helena | 22,730 | Ten Mile Creek | 50,060 | -- |
| Lewistown | 6,437 | Big Spring Creek | 55,997 | 115 |
| Libby | 3,286 | Kootenai River | 85,614 | 32 |
| Livingston | 6,883 | Yellowstone River | 70,991 | 50 |
| Missoula | 29,497 | Clark Fork River | 331,213 | 60 |
| Shelby | 3,111 | Marias River | 67,258 | 284 |
| Sidney | 4,543 | Yellowstone River | ? | 7 |

*TSS = Total Suspended Solids

1) Anaconda--Data indicate Warm Springs Creek probably is degraded by stormwater pollutants. In addition, the problem is likely further compounded by the fact that the area is used extensively by industry. The area warrants additional study since Warm Springs Creek flows through an extensively used municipal park.

2) Butte--Located in another heavy industrialized area, Blacktail Creek is also apparently significantly affected by stormwater runoff. Though Silver Bow Creek also receives a portion of the city's runoff, the stream is already heavily impacted and has no quality limits. Because of growth potential in the Blacktail Creek drainage, further investigation of the area to quantify impacts and assess treatment needs is warranted.

3) Cut Bank--Most of the stormwater pollutant load from Cut Bank enters Cut Bank Creek. Field investigations are likely to document biological degradation since stormwater, sewage, and water treatment wastes are all discharged at the same point.

4) Glasgow--Since quality of the Milk River is fairly poor with high total suspended solids, the additional impact from stormwater runoff is not considered to be significant.

5) Havre--Though data indicated the Milk River may be adversely affected by Havre's stormwater runoff, a subsequent biological analysis showed benthic populations below the stormwater discharge point were similar in quality and quantity to those above the point. Apparently, as at Glasgow, inherent poor quality of the Milk River has resulted in stormwater loadings being received without any apparent additional degradation from a biological standpoint.

6) Helena--MDT for Ten Mile Creek was not calculated since much sediment settles prior to reaching the discharge point and the stream is intermittent. No significant problems are thought to be occuring; however, continuing development in the area will necessitate additional data collection to adequately monitor the increasing pollution potential.

Ultimate effects of stormwater runoff are contingent on the receiving streams assimilative capacity which is in turn dependent on stream size and flow rate. Degree of impact is also related to stream quality prior to stormwater discharge. For example, in a stream with inherent high sediment loads such as the Milk River, additional impact of stormwater runoff apparently has a negligible effect. However, data are inadequate to show what would happen to the quality of such streams as the Milk River should stormwater pollutant loads be discontinued.

In any case, the need for further field investigation to more accurately determine the effect of stormwater pollution from larger towns is justified. As a result, a more detailed, technical study of stormwater runoff, described on page 143 was initiated by the Statewide 208 project.

Since the overall impact of small town stormwater runoff is negligible at this point, the assessment consisted of mapping flow directions of runoff

water and a short narrative describing any pertinent conditions. The report by Brown and Garvin (1977) contains this information which will be used by the WQB in any future management considerations should any of these towns experience substantial growth.

industrial runoff--Of the five industrial sites examined, none were suspected to be causing any significant water quality problems.

The Anaconda Company's copper smelting operation in Anaconda generates 174,107 pounds/year of total suspended solids; however, runoff is collected in a treatment lagoon prior to discharge to the Clark Fork River. The Company also has a copper refining operation near Great Falls on the Missouri River. Pollutant loads for total suspended solids were calculated to be 94,728 lbs/year. MDT was estimated to be only 4.08 hours. Though both operations are not apparently contributing to stormwater degradation, the model used does not address heavy metal pollution which may be a problem in both cases,

The wood products plant at Missoula, operated by Hoerner Waldorf, is a fairly extensive operation. However, all runoff enters a treatment system or percolates into the ground and no stormwater pollutant loads are contributed to surface waters.

Similarly, the Holly Sugar Industry at Sidney discharges contaminated runoff into a holding pond during operation. During the off-season, discharge is directly to the Yellowstone River; but since plant operations are minimal then, the Yellowstone River is probably not being adversely affected by stormwater discharges.

Malmstrom Air Force Base runoff has been sampled extensively, but the monitoring program has been so poorly planned, meaningful data are lacking. At this point, the degree of stormwater impact is unknown.

Mining--There are 183 mining districts in the Statewide 208 study area. Many of these districts experience little or no mining today, but with more sophisticated exploration methods and changing economic conditions, many districts may become productive again.

The majority of existing and projected mining occurs in that part of Montana with highest quality waters of local and national significance from a recreational standpoint. In particular, the upper Clark Fork River and upper Missouri River basins contain some excellent quality waters, have some of the finest trout fisheries in the Continental United States, and contain a major portion of existing and proposed mining activities. The resource conflict is apparent and emphasizes the need for development of strategies to prevent mining related impacts on Montana's water. In partial fulfillment of this need, the Water Quality Bureau contracted with Westech to assess mining NPS pollution; the following discussion is extracted from the Westech report by Schmidt and Botz (1978).

mineral commodities--Of the 36 minerals occurring in commercially important quantities in the Statewide 208 Area, 25 have been mined in the

past or are mined today. Table 12 summarizes current statewide production and projection information for the individual commodities. Twelve mineral commodities will experience the most significant levels of production in Montana in the next 10-20 years. These commodities are: bauxite, bentonite, copper, gold, lead, phosphate, sand and gravel, silver, talc, tungsten, vermiculite, and zinc. Other commodities that will experience development, but of a smaller magnitude, are: antimony, fluorspar, gemstones, limestone, silica, and possibly graphite. Locations and activity of mines for these commodities in the Statewide 208 area are listed in Table 13.

mineral fuels--

1) coal--Future production of Montana coal has been projected at 43.6 million tons by 1980 and 101.1 million tons by 1985. Most of this production is expected to occur in the Powder River Basin which is outside the Statewide 208 study area.

Within the Statewide 208 area, lignite development is projected in three areas: (1) Dreyer Brothers' Circle West Ranch in McCone County at one million tons per year in 1984 and five million tons in 1985; (2) Knife River Mine at Savage in Richland County, increasing from the current 300,000 tons/year to 400,000/year in 1979, (3) Wibaux area in Wibaux County.

The Bell Mountain area north of Billings and portions of Hill, Blaine, Liberty, Choteau, and Fergus counties have reserves of sub-bituminous coal. Smaller areas along the front of the Rocky Mountains near the Canadian Border and between Great Falls and Lewistown have discontinuous deposits of bituminous coal; present activity in these areas is limited.

Total coal reserve in Montana is estimated to be 108 billion tons, which amounts to over 25 percent of known coal reserves in the entire U.S. Table 14 locates major coal fields in the Statewide 208 study area and indicates their potential for development.

2) natural gas--The American Gas Association has estimated Montana's gas reserves to total 930 billion cubic feet. Major fields occur in eastern and north central portions of the state, particularly between Cut Bank and Glasgow.

Exploration and development of natural gas reserves are continuing. Numerous discoveries and new field extensions have occurred in Choteau, Glacier, Hill, Liberty, Pondera, Toole, Phillips, and Blaine counties. Future natural gas development in Montana will probably be extensive in the potentially vast unexplored resources of the Rocky Mountains Overthrust Belt which has been described as the "hottest new area for drilling in the United States." Extensive application for oil and gas leases from various national forests document interest in this area. (Table 15)

3) oil--Major oil producing fields in the Statewide 208 study area are near Cutbank (Pondera and Teton Counties), near Wolf Point (Roosevelt County), east of the Big Snowy Mountains (Fergus, Petroleum, and Musselshell Counties), and west of Sidney (Richland County). Oil exploration activities in Montana have been continuous and are expected to increase as the nationwide shortage of crude oil increases. Proven reserves of crude

TABLE 12

MINERAL COMMODITIES DATA SUMMARY*

| Commodity and Method Mined. U-Underground S-Strip O-Open Pit Quarry | Has Been Mined | Being Mined N-None S-Small M-Medium L-Large | Potential for Future Development N,S,M,L I-increased production expected P-Proven mineable resources will be developed under right economic circumstances | Is Montana a nationally major supplier? | Nature of existing or potential water quality problems | Comments |
|---|---|---|---|---|---|---|
| Antimony (U) | Yes | S-1 mine | S/I | Yes/but total domestic production is insignificant | Acid mine drainage arsenic | U.S. imports, 1-2 mines supply most of U.S. production |
| Arsenic | Smelter By-product | Smelter By-product | Only as smelter by-product | Yes | Acid mine drainage toxic to humans and aquatic life (Mining) | Butte is largest domestic producer |
| Asbestos (O,U) | Yes | N | N | --- | None in Montana; problem is fiber gets into drinking water | U.S. imports |
| Barite (O) | Yes | S-3 mines | M/I | No | None in Montana; some salts in barium toxic to humans | U.S. is large importer, but has reserves |
| Bentonite (S) | Yes | M | L/I | Yes | Sediment, turbidity and dissolved soilds | U.S. is self-sufficient: Montana, Wyoming & South Dakota have 90 percent of worlds mineable deposits |

| ommodity<br>nd Method<br>ined.<br>-Underground<br>-Strip<br>-Open Pit Quarry | Has Been Mined | Being Mined<br>N-None<br>S-Small<br>M-Medium<br>L-Large | Potential for Future Development N,S,M,L I-Increased production expected P-Proven mineable resources will be developed under right economic circumstances | Is Montana a nationally major supplier? | Nature of existing or potential water quality problems | Comments |
|---|---|---|---|---|---|---|
| ismuth | Smelter By-product | Smelter By-product | Only as smelter by-product | No | | U.S. imports most of its needs |
| Cadmium | Smelter By-product | Smelter By-product | Only as smelter by-product | No | | U.S. imports |
| Chromium (U) | Yes | N | N | -- | Possible acid mine drainage from associated ores | U.S. imports 90 percent of its needs |
| Clay (S) | Yes | N | S/P | No | Minimal-dissolved solids and suspended sediment | U.S. exports |
| Copper (U,O) | Yes | L | L/P | Yes | Acid mine drainage | U.S. is largest producer |
| Fluorspar (O,U) | Yes | S | M/P | Yes | None in Montana; excess fluoride concentrations in water | U.S. imports 80 percent of its needs |
| Gems (O) | Yes | S | S/I | Yes | Minor problems in Montana; sediment and turbidity | U.S. imports and exports |

| Commodity and Method Mined. U-Underground S-Strip O-Open Pit Quarry | Has Been Mined | Being Mined N-None S-Small M-Medium L-Large | Potential for Future Development N,S,M,L I-Increased production expected P-Proven mineable resources will be developed under right economic circumstances | Is Montana a nationally major supplier? | Nature of existing or potential water quality problems | Comments |
|---|---|---|---|---|---|---|
| Gold (O,U) | Yes | M | M/I | Yes | Severe-sediment from placer Sever-cyanide leaching Severe-acid mine drainage | U.S. imports, Montana is 1 of states producing 96 percent of U.S. gold |
| Graphite (O,U) | Yes | S | S/I | No | Minimal suspended sediment | U.S. imports |
| Gypsum and Anhydrite (O) | Yes | S-M | M/I | No | Increased salinity and hardness of water; waste dump erosion problems | U.S. is self-sufficient U.S. is largest producer |
| Iron (O) | Yes | S | M/P | No | Minimal in Montana, can be toxic to aquatic life | U.S. is among major producers |
| Lead (U) | Yes | S | M/P | No | Acid mine drainage | U.S. is largest producer |
| Limestone (O) | Yes | M | M/I | No | Minimal-sediment | U.S. is self-sufficient |
| Manganese (U) | Yes | N | S/P | Yes in 1960's | Minimal | U.S. imports |
| Molybdenum (U,O) | No | N | S/P | --- | May significantly affect irrigation water | U.S. exports |

| ommodity nd Method ined. -Underground -Strip -Open Pit Quarry | Has Been Mined | Being Mined N-None S-Small M-Medium L-Large | Potential for Future Development N,S,M,L I-Increased production expected P-Proven mineable resources will be developed under right economic circumstances | Is Montana a nationally major supplier? | Nature of existing or potential water quality problems | Comments |
|---|---|---|---|---|---|---|
| iobium olumbium) (U,0) | No | N | N | -- | Minimal-Sediment | U.S. imports all needs could be self-sufficient |
| egmatite nerals (U,0) | Yes | S-Feldspar | S/P-Feldspar | No | | U.S. exports feldspar; U.S. has large reserve of scrap and flake mica; U.S. has sufficient reserves of beryllium minerals |
| osphate (0) | Yes | M-1 Mine | L/P, expected after 1990 | No | Suspended sediment potential problem from uranium associated with phosphate rock | U.S. is self-sufficient; potential exists for Montana to become major U.S. producer |
| and & Gravel (S) | Yes | L | L/I | -- | Sediment and turbidity, alteration of stream channels | U.S. is self-sufficient |
| ilica (0) | Yes | S | M/I | No | Sediment problems | U.S. has large reserves |
| illimanite inerals (U,0) | No | N | N | -- | | Large reserves in U.S. |

| Commodity and Method Mined. U-Underground S-Strip O-Open Pit Quarry | Has Been Mined | Being Mined N-None S-Small M-Medium L-Large | Potential for Future Development N,S,M,L I-Increased production expected P-Proven mineable resources will be developed under right economic circumstances | Is Montana a nationally major supplier? | Nature of existing or potential water quality problems | Comments |
|---|---|---|---|---|---|---|
| Silver (U,O) | Yes | L-mostly by-product | M/P | Yes | Acid mine drainage | U.S. imports; along with 2 other states; Montana produces 24 percent of domestic output |
| Sodium Sulfate (O) | No | N | N | No | | U.S. has large reserves but imports some |
| Stone (O) | Yes | M | M/I | No | Minimal-sediment | U.S. is self-sufficient |
| Sulfur | By-product | S By-product | Only as by-product | No | Some sulfide minerals produce acid water | U.S. reserves are of world total, imports some |
| Talc (O) | Yes | M | L/I | Yes | Waste dump erosion problems | U.S. is self-sufficient Montana is 4th largest producing state |
| Thorium & Rare Earths (U,O) | Yes | N | S/I | --- | Radioactivity | U.S. has large reserves |
| Titanium (O) | No | N | N | --- | None in Montana; little known about the problem | U.S. imports but could produce for all needs |

| Commodity and Method Mined. U-Underground S-Strip O-Open Pit Quarry | Has Been Mined | Being Mined N-None S-Small M-Medium L-Large | Potential for Future Development N,S,M,L I-Increased production expected P-Proven mineable resources will be developed under right economic circumstances | Is Montana a nationally major supplier? | Nature of existing or potential water quality problems | Comments |
|---|---|---|---|---|---|---|
| Tungsten (O) | Yes | S | L/P | No | None in Montana Metals problem known at California mine | U.S. able to produce 75 percent of needs |
| Vermiculite | Yes | L | L/I | Yes | Large disturbance area; past tailings/sedimentation impacts | U.S. largest producer; most U.S. production is from Montana |
| Zinc (U,O) | Yes | By-product of copper mining | M/P | No | Acid mine drainage | U.S. imports |

TABLE 13

LOCATION AND ACTIVITY OF MAJOR MINERAL COMMODITY MINES IN THE STATEWIDE 208 STUDY AREA

| Commodity | Location | Activity |
|---|---|---|
| Antimony | Babbitt mine, Sanders County | responsible for ½ U.S. production |
| Bauxite | Missoula & Mineral Counties | active |
| Bentonite | Central and NC Montana | some operating, some proposed |
| Copper | Butte | active - 99% of Mt.'s past production |
| | N.W. Montana | potential active |
| | Beartooth Mt. and Hughesville-Neihart area | active exploration |
| | Bull Lake, Lincoln County | proposed mine |
| Gold | Numerous | active & propose cyanide operations |
| Graphite | Jefferson Co. mine | being developed |
| Lead | Numerous locations associated with copper mines | some production, will increase |
| Phosphate | CW & SW Montana | deposits--expected to be developed |
| Sand & Gravel | Numerous | active |
| Talc | Beaverhead & Madison Co. | extensive exploration |
| Tungsten | Significant reserves | sporadic production will increase |
| Vermiculite | W.R. Grace Mine, Libby, Skalkaho Mts., Ravalli Co. | most of U.S Production Proposed |

TABLE 14

COAL FIELDS IN THE MONTANA STATEWIDE 208 AREA

| Field | County | Potential for Development In Next Ten Years |
|---|---|---|
| Garfield | Garfield | Low (some exploration) |
| Bull Mountain | Musselshell - Yellowstone | Moderate - existing small mines additional exploration - considerable leasing |
| Electric | Park | Low |
| Livingston - Trail Creek | Park | Low |
| Lombard | Broadwater | Low |
| Great Falls | Cascade | Low |
| Lewistown | Fergus - Judith Basin | Low |
| North Central | Liberty - Hill - Blaine - Choteau | Moderate - planned small mines - exploration activities |
| Blackfeet - Valier | Glacier - Pondera - Teton | Low |
| Western Tertiary Fields | Missoula - Granite | Low |
| Lamesteer | Wibaux | Low |
| Wibaux | Wibaux | Moderate - high, planned gasification facilities - intensive exploration activities |
| Little Beaver | Wibaux | " |
| Four Buttes | Wibaux | " |
| Hodges | Dawson - Wibaux | Low |
| Griffith Creek | Dawson | Low |
| Smith - Dry Creek | Wibaux - Richland | Low |

| | | |
|---|---|---|
| O'Brien - Alkali Creek | Richland | Low |
| Breezy Flat | Richland - Dawson | Moderate - existing mine - exploration activities |
| Burns Creek - Thirteen Mile Creek | Dawson - Richland | Moderate |
| Southwest Glendive | Dawson | Moderate |
| Fox Lake | Richland | Moderate - intensive exploration - and leasing activities |
| Lane | Richland | Moderate |
| Carroll | Richland - Dawson | Moderate |
| Redwater River | McCone - Dawson | Moderate |
| Weldon - Timber Creek | McCone | High - planned fertilizer plant - and other conversion facilities |
| Fort Kipp | Roosevelt | Low |
| Lanark | Roosevelt | Low |
| Medicine Lake | Sheridan | Low |
| Reserve | Sheridan | Low |
| Coal Ridge | Sheridan | Low |
| Little Sheep Mtn. | Prairie - McCone - Garfield | Low - moderate - considerable exploration and leasing |

TABLE 15

OIL AND GAS LEASING ACTIVITY
IN NATIONAL FOREST LAND
IN WESTERN MONTANA

| Forest | Acres Already Leased | Acres Applied For |
|---|---|---|
| Beaverhead | up to 350,000 | about 750,000 |
| Deer Lodge | one lease | about 185,000 |
| Flathead | 0 | about 500,000 |
| Gallatin | 70,000 | entire forest except Absaroka Range |
| Helena | 0 | about 100,000 |
| Lewis and Clark | 19,697 | 571,000 |
| Lolo | 0 | about 10,000 |

petroleum are estimated to be from 164 million barrels by the American Petroleum Institute to 255 million barrels by the Montana Department of Natural Resources and Conservation.

4) uranium--In Montana, fairly extensive uranium deposits occur in the Boulder Batholith in Jefferson County. Other deposits are located in Mineral, Ravalli, and Beaverhead counties in western lignite deposits, in shale and lignite beds of Lewis and Clark, Broadwater, and Jefferson counties, and in southwestern phosphorite deposits. Although there are unranium leases in ten counties of the Statewide 208 study area and prospecting is currently underway, no commercial deposits have been announced, and the possibilities for development of underground or open-pit uranium mines are poor.

mining-related water quality problems--Water quality impacts of commodity and fuel resource mining are dependent upon the methods used, eg., strip, open pit, or underground mining, and the type of practices employed during the mining operation. A number of impacts, such as mine drainage, sedimentation, erosion of waste dumps and accidental spills are general to the mining industry and not commodity specific. In addition, each specific resource can be responsible for a particular pollutant.

A subjective relationship of mining and water quality is shown in Table 16. Magnitude and intensity of impacts are highly variable and dependent on the type of mining and BMP's employed. Also, a specific commodity can occur in a variety of deposits having a varying potential to harm water quality. For example, copper can occur in sulfide deposits which can create substantial acid mine drainage or it can occur as oxides which pose much less of a problem. Since sedimentation is common to all types of mining, the impact is rated only for particularly important cases. Similarly, nutrients are present where explosives are used and nutrient impacts are rated for only the applicable commodities. Oil and grease problems are common to all mining and are not listed in the matrix.

Table 17 lists site specific water quality problems resulting from mining activities in the Statewide 208 study area. Although no more than 25 percent of the cited problems have supporting field data, some degree of water pollution could be documented at all sites. Mining related water quality problems have occurred in nearly every major drainage basin in central and western Montana (Figure 3). The 133 problems can be grouped into five main categories:

| Problem Type | Percentage |
|---|---|
| mine drainage | 17 |
| tailings and waste dump erosion | 34 |
| placer workings | 35 |
| sand and gravel mining | 12 |
| roads and ground disturbance | 2 |

TABLE 16

IMPACT MATRIX RELATING MINING AND WATER QUALITY*

| Commodity Mined | Metals | pH-Acidity | Sediment-Turbidity | Common Ions | Nutrients | Other |
|---|---|---|---|---|---|---|
| Antimony | L | L | — | — | — | — |
| Asbestos | — | — | L | — | — | Asbestos Fibers |
| Barite | — | — | — | — | — | Barium |
| Bentonite | — | — | L | S | — | — |
| Chromium | S | S | — | — | — | — |
| Clay | — | — | L | S | — | — |
| Copper | L | L | — | L | S | — |
| Fluorine | — | — | — | S | — | Fluoride |
| Gems | — | — | S-L | — | — | — |
| Gold (Placer) | — | — | L | — | — | — |
| Gold (Lode) | L | L | — | L | — | Cyanide |
| Graphite | S? | — | — | — | — | — |
| Gypsum | — | — | L | L | S | Hardness |
| Iron | S-L | S | — | — | — | — |
| Limestone | — | S | — | S | S | Hardness |
| Lead | L | L | — | L | — | — |
| Manganese | L | L | — | L | — | — |
| Molybdenum | L | L | — | L | — | — |
| Niobium | — | — | — | — | — | — |
| Pegmetite | — | — | S | — | — | — |
| Phosphate | — | — | L | S | L | Phosphate |
| Sand & Gravel | — | — | L | — | — | — |

| Commodity Mined | Metals | pH-Acidity | Sediment-Turbidity | Common Ions | Nutrients | Other |
|---|---|---|---|---|---|---|
| Silica | — | — | S | — | — | — |
| Silver | L | L | — | L | — | — |
| Sodium Sulfate | — | — | — | L | — | — |
| Stone | — | — | S | — | — | — |
| Talc | — | — | S-L | — | — | — |
| Thorium | S | S | — | — | — | Radio-Activity |
| Titanium | — | — | L | — | S | — |
| Tungsten | S | S | — | — | — | — |
| Uranium | S-L | S-L | S-L | — | — | Radio-Activity |
| Vermiculite | — | — | L | — | S | — |
| Zinc | L | L | | L | | |
| Coal | S | S | L | L | L | — |
| Oil | — | — | — | L | — | — |
| Natural Gas | — | — | S-L | — | — | Methane |

*L = Potential Large Impact

S = Potential Small Impact

Blank = No Impact Expected

TABLE 17

MINING-RELATED WATER QUALITY PROBLEMS IN THE STATEWIDE 208 AREA

Hard Rock Mining

| Drainage Basin | County | Mining District/ or mine operator * | Drainage | Water Quality Problem |
|---|---|---|---|---|
| (1) 40EJ | Phillips | Ruby Gulch Group I | Ruby Creek/ Missouri Rv. | Tailings washed into stream |
| (2) 40EJ | Phillips | Gold Bug Mine I | Montana Gulch/ Rock Creek/ Missouri Rv. | Acid mine drainage problems |
| (3) 40I | Phillips | Little Ben Mine I | King Ck./ Peoples Ck./ Milk River | Tailings washed into stream |
| (4) 41D | Beaver-head | Tomatan/ Mine O | Placer Ck./ Trail Ck./ North Fk. Big Hole Rv. | Developed access road up stream bed to get to expl. adit; construction has undercut slope |
| (5) 41D | Beaver-head | Elkhorn I | Elkhorn Ck./ Wise Rv./ Big Hole Rv. | Old adit discharges acid waters to ck |
| (6) 41D | Madison | Rochester Mining District I | Rochester Ck./ Big Hole Rv. | Extensive old mining; dumps have high amounts sulfide minerals; dumps erode into stream |
| (7) 41E | Jeffer-son | Crystal O | Uncle Sam Gulch/ Cataract Ck./Boulder Rv. | Creek runs through pit and transports area waste |
| (8) 41E | Jefferson | Comet I | High Ore Ck./ Boulder Rv. | Tailings disposed in in Creek |
| (9) 41E | Jefferson | Elkhorn Queen I | Elkhorn Ck./ Boulder Rv./ Jefferson Rv. | Runoff from dumps and tailings; looks bad for ½ mile from mine |
| (10) 41G | Madison | Mammoth A | South Boulder River/Jefferson River | Runoff from precipitation washes tailings into creek; ore minerals auriferous pyrite and chalcophyrite, sphalerite |

TABLE 17, Continued

| Drainage Basin | County | Mining District/ or mine operator * | Drainage | Water Quality Problem |
|---|---|---|---|---|
| (11) 41I | Broadwater | Argo I | Hellgate Gulch/ Canyon Ferry Lake | Some acid drainage; some dump erosion |
| (12) 41I | Broadwater | Klein-Schmidt I<br>January I<br>E. Pacific O | Weasel Ck./ Beaver Ck./ Canyon Ferry Lake | Acid mine drainage |
| (13) 41Q | Cascade | Neihart Mining District A | Carpenter Ck./ Belt Ck./ Missouri Rv. | Old tailings ponds and dumps are actively eroding into ck. |
| (14) 41Q | Cascade | Silver Dyke A | Carpenter Ck./ Belt Ck./ Missouri Rv. | 15-20 gpm discharge into creek |
| (15) 41Q | Judith Basin | Block P A | Dry Fork/ Belt Ck./ Missouri Rv. | Discharge - seepage from waste dump |
| (16) 41QJ | Lewis & Clark | Gould Mine A | Gould Ck. & Fool Hen Ck./ Virginia Ck./ Canyon Ck./ Little Prickly Pear Ck./ Missouri River | Acid mine drainage and waste dump erosion |
| (17) 43B | Park | Jardine A | Bear Ck./ Yellowstone Rv. | Tailings have slumped into creek |
| (18) 43C | Park | McLaren I | Daisy Creek/ Stillwater Rv. | "Ponding of snowmelt and rainfall waters in disturbed areas, resulting in runoff and groundwater emerging with high, heavy metal concentrations." |
| (19) 43D | Park | Glengary I | Fisher Ck./ Clark Fork of Yellowstone | Infiltration into mine from two raises and groundwater seeps; ponding of snowmelt and rainfall waters which then pass through disturbed material, result in discharges of high acidity, high in sulfate, iron, and aluminum |

TABLE 17, Continued

| Drainage Basin | County | Mining District/ or mine operator * | Drainage | Water Quality Problem |
|---|---|---|---|---|
| (20) 76C | Lincoln | A | Silver Butte Creek/East Fisher Creek/Fisher Rv. | Discharge from adit for 40 yrs.; seeps into ground prior to reaching creek |
| (21) 76D | Lincoln | Snowshoe A | Snowshoe Ck./ Big Cherry Ck./ Libby Ck. | |
| (22) 76E | Granite | A | Brewster Ck./ Rock Cr. | Shaft with discharge immediately next to the creek. |
| (23) 76F | Lewis & Clark | Mike Horse/ Heddelston District I | | Acid mine drainage; tailings dam burst depositing tailings in ck.; necessitated excavations in ck. for gravel to rebuild dam |
| (24) 76F | Lewis & Clark | Sevenup Pete A | Sevenup Pete Ck./Blackfoot River | Erosion of waste dumps |
| (25) 76G | Deer-Lodge | Cable Mine A | Cable Ck./ Warm Springs Clark Fork | Tailings are quicksand swampy below dumps; Mg staining on mill dumps |
| (26) 76G | Deer-Lodge | | South Fork Dry Cottonwood Ck./ Clark Fork | Adit mine discharge; quality unknown |
| (27) 76G | Deer-Lodge | Champion | Orofino Ck./ Clark Fork | Adit has discharge into Impacts creek |
| (28) 76G | Granite | Hidden Lake | Warm Springs Creek/Clark Fork | Adit has discharge; no water quality data; ore minerals - pyrite quartz vein |
| (29) 76G | Granite | Forest Rose A | Dunkleberg Ck./ Clark Fork | Acid mine drainage; erosion of tailings; culvert under tailings plugged; major flood will wash out tailings; ore minerals - argentiferous galena, sphalerite, pyrite, angeloite, cerussite, smithsonite |

TABLE 17, Continued

| Drainage Basin | County | Mining District/ or mine operator * | Drainage | Water Quality Problem |
|---|---|---|---|---|
| (30) 76G | Powell | A | Rocker Gulch/ Cottonwood Ck./ Clark Fork | Mine discharg of unknown quality |
| (31) 76G | Powell | Master I | Gold Ck./ Clark Fork | |
| (32) 76G | Silver Bow | Butte Highlands 0 | Basin Ck./ Silver Bow | Old adit discharges to stream; ore - auriferous pyrite & pyrhatite, galena, sphalerite, chalcopyrite |
| (33) 76G | Silver Bow | Berkeley Pit/Butte Underground Mines 0 | Silver Bow Ck./ Clark Fork | Anaconda effluent main source of flow in Silver Bow Ck.;old mill tailings also erode into creek |
| (34) 76GJ | Granite | Wasa A | Douglas Ck./ | Acid mine drainage; ore minerals - sphalerite, pyrite, chalcopyrite |
| (35) 76GJ | Granite | Phillipsburg Mining District | Flint Ck./ Clark Fork | Tailings erosion, adit discharges |
| (36) 76M | Mineral | Nancy Lee 0 | Keystone Ck. | Tailings piled near dry channel; apparently acidic discharge from old adit but does not reach a perennial stream |
| (37) 76M | Mineral | Tarbox A | Packer Ck./ St. Regis Rv./ Clark Fork | Stream runs through old waste dumps |
| (38) 76M | Mineral | Bud King Missoula 0 | Pardee Ck./ Clark Fork | Discharge from old adit may reach creek |
| (39) 76M | Missoula | A | Kennedy Ck./ Ninemile Ck./ Clark Fork | Old adit discharge to ck. |
| (40) 76M | Missoula | Joe Wallit, Missoula A | St. Louis Ck./ Ninemile Creek | Stream erodes waste pile; stream blocked at times |

TABLE 17, Continued

| Drainage Basin | County | Mining District/ or mine operator * | Drainage | Water Quality Problem |
|---|---|---|---|---|
| (41) 76N | Sanders | Holliday I | West Fork Pilgrim Ck. | Stream runs through tailings dump |
| (42) 76N | Sanders | Jack Waite I | Dixie Ck./ Beaver Ck. | Waste from old workings in and alongside creek; ore minerals - galena, sphalerite, tetrahedrite, pyrite, chalcopyrite |
| (43) 76N | Sanders | Heidelberg A | East Fork Rock Creek | Old adit discharges to stream |
| (44) 76N | Sanders | State Mining Co. | Eddy Creek | Waste debris in creek; discharge from adit into creek |
| | | Mills | | |
| (45) 41B | Beaverhead | Gold Leaf A | Grasshopper Creek/ Beaverhead Rv. | Creek has eroded into tailings pond; opposite bank of oversize gravel from hydraulic mining eroding; runoff across tailings carrying tailings into creek |
| (46) 41B | Beaverhead | | Rattlesnake Ck./ Beaverhead Rv. | Sediment from mill tailings |
| (47) 41D | Beaverhead | Mining & Minerals Resource Corp. I | Sappington Ck./ Trapper Ck./ Big Hole Rv. | In 12/75 dike of tailings burst 30-50 tons of tailings exited a portion into creek and into Trapper Ck. |
| (48) 41QJ | Lewis & Clark | Gould A | Fool Hen Creek Virginia Creek Canyon Creek Little Prickly Pear Creek | Mill tailings washed by acid mine drainage |
| (49) 76GJ | Granite | Old Red Mill A | Douglas Creek/ Flint Creek | |

TABLE 17, Continued

| Drainage Basin | County | Mining District/ or mine operator * | Drainage | Water Quality Problem |
|---|---|---|---|---|
| (50) 43B | Park | McLaren Mill A | Soda Butte Ck./ Lamar Rv./ Yellowstone Rv. | Erosion of tailings into into creek |
| (51) 76GJ | Granite | A | Boulder Ck./ Flint Creek | Eroding tailings |
| (52) 76F | Lewis & Clark | A | Blackfoot Rv. | Acid mine tailings erode into stream |
| | | Gold (Cyanide Leach) | | |
| (53) 41I | Lewis & Clark | John B. White leach mill I | Silver Creek/ Missouri Rv. | 2/77 (?) leaks in holding ponds; road build across creek, no culvert |
| (54) 41B | Beaver-head | Hendrich Mine | Grasshopper Creek/Beaver-head River | Runoff into creek from tailings pond |
| (55) 41B | Beaver-head | Ermont A | Ermont Gulch/ Beaverhead River | Runoff from cyanide leach dumps |
| (56) 41C | Madison | Virginia City/ Sheitland O | Alder Gulch/ Ruby River | Tailings pond in valley bottom; potential prob-lem if large flooding |
| | | Coal | | |
| (57) 41QJ | Cascade | Sand Coulee Mining Area A | Sand Coulee Creek/Missouri River | 9 old mines discharging acid waters |
| | | Fluorspar | | |
| (58) 76M | Mineral | Snowbird O | Cedar Log Creek/ Fish Creek/ Clark Fork | Discharge from operations reaches creek |

TABLE 17, Continued

| Drainage Basin | County | Mining District/ or mine * operator | Drainage | Water Quality Problem |
|---|---|---|---|---|
| | | Gems | | |
| (59) 41S | Judith Basin | Yogo Sapphire 0 | Yogo Creek/ Judith Riv. | Tailings pond could be washed out by flood; washing operation may go into creek |
| | | Graphite | | |
| (60) 41I | Broadwater | National Minerals Corp. 0 | Indian Creek/ Missouri Riv. | Water discharging from adit and may flow into Indian Creek at high flow |
| | | Gypsum | | |
| (61) 41S | Fergus | Shoemaker Mine/U.S. Gypsum 0 | Big Springs Creek/Judith River/Missouri River | Waste dump erosion |
| | | Limestone | | |
| (62) 41I | Jefferson | Montana City Quarry/ Kaiser 0 | Prickly Pear Creek | Waste dump slumped into Prickly Pear Creek |
| | | Phosphate | | |
| (63) 76G | Powell | Brock (Anderson)/ Cominco Amer. 0 | Brock Creek/ Clark Fork River | Mine yard and crusher in stream bed |

TABLE 17, Continued

| Drainage Basin | County | Mining District/ or mine * operator | Drainage | Water Quality Problem |
|---|---|---|---|---|
| | | Talc | | |
| (64) 41B | Beaverhead | Smith-Dillon A | Axes Creek/ Blacktail Deer Creek/ Beaverhead River | Wastes erode into creek |
| (65) 41B | Madison | Treasure Chest Treasure State | Left Fork & Middle Fork/ Stone Creek/ Beaverhead River | Potential Water pollution problem from hillside waste dumps (WQB Memo) |
| (66) 41B | Madison | Regal | Carter Creek & Hoffman Creek/ Beaverhead Rv. | Waste rock placed in head of drainage |
| | | Quartz | | |
| (67) 41E | Jefferson | Basin Quartz Quarry/Pacific Silica 0 | Boulder River | Discharge sediment from settling ponds (1974) WQB report on inadequacies of mine site for controlling erosion into creek |
| | | Vermiculite | | |
| (68) 76D | Lincoln | Vermiculite Mtn. Mine/ W.R. Grace 0 | Rainy Ck./ Kootenai Rv. | Old tailings deposited in Creek; Erosion at mine area may cause problems |

TABLE 17, Continued

| Drainage Basin | County | Mining District/ or mine * operator | Drainage | Water Quality Problem |
|---|---|---|---|---|
| | | Sand and Gravel | | |
| (69) 41E | Jefferson | Montana Dept. of Highways 0 | Boulder River | Mining terrace of Boulder River close to river, stream capture of mined area likely since MDH has not put in promised rip rap |
| (70) 41G | Jefferson | Continental Concrete Co. 0 | Jefferson River | Mining terrace of Jefferson River; dewaters pit by discharging to river; may be stream capture |
| (71) 40J | Hill | Hill County A | Beaver Creek/ Milk River | Former pit on terrace of Beaver Creek; stream has captured pit; gravel berms have been ineffective |
| (72) 41K | Cascade | Big Sky Sand and Gravel 0 | Sun River | Mining streambed of Sun River, wash plant on terrace may discharge to river |
| (73) 41K | Cascade | Lewis Construction Co. 0 | Sun River | Mining streambed of Sun River, wash plant on terrace may discharge to river |
| (74) 410 | Teton | ? 0 | Teton River | "Extraction of gravel in stream channel has aggravated lateral erosion and caused widening of flood channel. Depletion of bed-load on property has caused subsequent post-flood head-cutting, scouring, erosion |
| (75) 410 | Choteau | Charles J. Naeseth A | Teton River | Mining streambed of Teton River; dumps excess concrete into river/has agreed to move |
| (76) 41S | Fergus | McDonald Ready Mix 0 | Boyd Creek/ Big Spring Creek/ Judith River | Settling pond overflow may impact stream |

TABLE 17, Continued

| Drainage Basin | County | Mining District/ or mine * operator | Drainage | Water Quality Problem |
|---|---|---|---|---|
| (77) 42M | Dawson | Dawson County 0 | Morgan Creek | Mining streambed of creek |
| (78) 42M | Dawson | Fisher Sand and Gravel 0 | Sevenmile Creek/ Yellowstone | Mining activity, stockpiles, disturbance in channel and floodplain of Seven-mile Creek |
| (79) 42M | Dawson | Dawson County 0 | Sevenmile Creek/ Yellowstone | Mining streambed of creek |
| (80) 42M | Richland | Sidney Ready Mix 0 | Lone Tree Creek/ Yellowstone | Settling pond "has potential and probably has overflow into creek" |
| (81) 43B | Park | Eggar Const. 0 | Yellowstone | Mining island of Yellowstone |
| (82) 76D | Lincoln | Granite Concrete Co. 0 | Cherry Creek/ Libby Creek & Libby Creek | Mine streambeds of Cherry Creek and Libby Creek at low flow |
| (83) 76G | Deerlodge | Montana Dept. of Highways I | Clark Fork | Pit has intercepted ground-waters high in iron and fluoride; no adequate reclama-tion plan for area has been proposed |
| (84) 76H | Ravalli | Donaldson Ready Mix 0 | Bitterroot River | Mining streambed of Bitter-root |
| (85) 76H | Ravalli | A & B Con-crete 0 | Bitterroot River | Inadequate settling, turbid waters discharged to slough which flows to Bitterroot |
| (86) 76H | Ravalli | A & B Con-crete I | Bitterroot River | Pit opened illegally on actively eroding bank of Bitterroot |
| (87) 76M | Missoula | MonRoc 0 | Clark Fork | Mining gravel bar of Clark Fork; mining area floods yearly |

TABLE 17, Continued

| Drainage Basin | County | Mining District/ or mine operator * | Drainage | Water Quality Problem |
|---|---|---|---|---|
| | | Placer Gold | | |
| (88) 41A | Beaverhead | | Jeff Davis Creek/ Horse Prairie Creek/Clark Canyon Dam | Erosion/sediment deposition producing streamflow alterations |
| (89) 41B | Beaverhead | | Grasshopper Creek/Beaverhead River | Severe sediment deposition producing stream flow alterations (approx. 24 km of stream affected) |
| (90) 41B | Beaverhead | | Dyce Creek/Grass-hopper Creek/ Beaverhead River | Sediment deposition producing stream flow alterations |
| (91) 41C | Madison | 0 | Browns Gulch/ Barton Bulch/ Ruby River | Erosion and sedimentation from placer operation |
| (92) 41C | Madison | | Alder Gulch/ Ruby River | Extensive placer mining since 1863 has left stream as a series of dredge piles |
| (93) 41C | Madison | | Harris Creek/ Ruby River | Old placer workings; old dumps and tailings from hardrock minings impact streams as well as distur-bance from placer mining; high spring sediment loads |
| (94) 41C | Madison | | Ramshorn Creek/ Ruby River | " |
| (95) 41C | Madison | | Mill Creek/ Ruby River | " |
| (96) 41C | Madison | | Indian Creek/ Ruby River | " |
| (97) 41C | Madison | | Wisconsin Creek/ Ruby River | " |
| (98) 41C | Madison | | Dry Georgia Gulch/ Ruby River | " |

TABLE 17, Continued

| Drainage Basin | County | Mining District/ or mine * operator | Drainage | Water Quality Problem |
|---|---|---|---|---|
| (99) 41C | Madison | | Goodrich Gulch/ Ruby River | Old placer workings; old dumps and tailings from hardrock minings impact streams as well as disturbance from placer mining; high spring sediment loads |
| (100) 41C | Madison | | Barton Gulch/ Ruby River | Old placer workings have caused sediment problems |
| (101) 41C | Madison | | Bivin Creek/ Ruby River | Sedimentation; reduction of trout population |
| (102) 41C | Madison | | California Creek/ Ruby River | Sedimentation; reduction of trout population |
| (103) 41C | Madison | | Warm Spring Creek/ Ruby River | Sediment deposition and stream channel alteration |
| (104) 41D | Silver Bow | | Moose Creek/Big Hole River | Old placer mining still causing siltation problems |
| (105) 41D | Silver Bow/ | | Camp Creek/Big Hole River | Old placer mining still causing siltation problems |
| (106) 41D | Silver Bow | | Soap Gulch/Big Hole River | Old placer mining still causing siltation problems |
| (107) 41G | Madison | | Bear Gulch/Jefferson River | Old placer workings; old dumps and tailings from hardrock minings impact streams as well as disturbance from placer mining; high spring sediment loads |
| (108) 41G | Madison | | Coal Creek/Jefferson River | " |
| (109) 41G | Madison | | Beall Creek/Jefferson River | " |
| (110) 41I | Broadwater | David Boomer Robert Carson O | Cooney Gulch/ Avalanche Gulch/ Canyon Ferry Lake | Discharges directly to creek; no settling ponds |

TABLE 17, Continued

| Drainage Basin | County | Mining District/ or mine * operator | Drainage | Water Quality Problem |
|---|---|---|---|---|
| (111) 41I | Broadwater | | Conferate Gulch/ Canyon Ferry Lake | High sediment loads in spring |
| (112) 41I | Lewis & Clark | Harold Ellingson Steve Walks 0 | Soup Creek/ Hauser Lake | Occasionally discharges to ephemeral drainage |
| (113) 41I | Lewis & Clark | Harvey Paul 0 | Walker Creek/ Tenmile Creek/ Hauser Lake | Pick and shovel work in streambed of perennial stream |
| (114) 76B | Lincoln | | Yaak River | Discharges to stream; no obvious impacts |
| (115) 76E | Granite | Tim Gregori 0 | Solomon Creek/ Rock Creek | Very small operation with discharge to stream; no apparent impacts |
| (116) 76F | Lewis & Clark | | Beaver Creek/ Blackfoot River | Occasional sediment problems |
| (117) 76F | Lewis & Clark | | Stonewall Creek/ Blackfoot River | Occasional sediment problems |
| (118) 76F | Lewis & Clark | | Keep Cool Creek/ Blackfoot River | Occasional sediment problems |
| (119) 76F | Lewis & Clark | | Poorman Creek/ Blackfoot River | Very small placer mining; dozing into creek |
| (120) 76F | Powell | | American Gulch & Washington Creek & Jefferson Creek Madison Gulch & Buffalo Creek/ Nevada Creek/ Blackfoot River | Intermittent placer workings; worked by small mines each year |
| (121) 76F | Powell | | Douglas Creek & Nevada Creek/ Blackfoot River | Past siltation evident; ground clayey and swampy |
| (122) 76F | Missoula | O'Loughlin Austin D'Orazi 0 | Elk Creek/ Blackfoot River | Mining in bed of stream and/ or discharging to stream; sedimentation |

TABLE 17, Continued

| Drainage Basin | County | Mining District/ or mine * operator | Drainage | Water Quality Problem |
|---|---|---|---|---|
| (123) 76G | Deerlodge | | German Gulch/ Silver Bow Creek/ Clark Fork | During high water, creek runs with high loads braided channel |
| (124) 76G | Powell | Clark J. Smith 0 | Ophir Creek/ Carpenter Creek/ Little Blackfoot River | Discharge from small operation |
| (125) 76G | Powell | | Gold Creek/ Clark Fork | Siltation, N. & S. Forks, N. Fork diverted into S. Fork; severe erosion problems |
| (126) 76GJ | Granite | | Little Gold Creek/ Flint Creek | Diversion over glacial debris |
| (127) 76M | Mineral | Arpan 0 | Trout Creek/ Clark Fork | Small placer operation with discharge to stream; no obvious impacts; operates i streambed and floodplain |
| (128) 76M | Mineral | Coleman Brothers 0 | Meadow Creek/ Clark Fork | In spring, discharges to stream; does not have settling pond; downstream sedimentation problems |
| (129) 76M | Mineral | Pete Balison 0 | Quartz Creek/ Clark Fork | Discharges to stream; in past, settling ponds have inadequately settled discharge |
| (130) 76M | Missoula | Clay Lewis 0 | Ninemile Creek/ Clark Fork | Mine discharges to stream but no apparent problems except physical disturbance of streambed and floodplain |
| (131) 76M | Missoula | John Woodens 0 | Little McCormick Creek/McCormick Creek/Ninemile Creek/Clark Fork | Discharges to stream in spring; inadequate settling facilities |

TABLE 17, Continued

| Drainage Basin | County | Mining District/ or mine * operator | Drainage | Water Quality Problem |
|---|---|---|---|---|
| (132) 41D | Missoula | Fluto<br>0 | Favorite Gulch/ McCormick Creek/ Ninemile Creek/ Clark Fork | Discharges to stream; have corrected past settling pond problems |
| (133) 41D | Beaverhead | Jack DeBore<br>0 | Little Goosehorn Cr/Ruby Cr/ Big Hole River | Placer work beginning, discharge to stream through pond |

*

Operating - O
Inactive - I
Abandoned - A

# STATE OF MONTANA

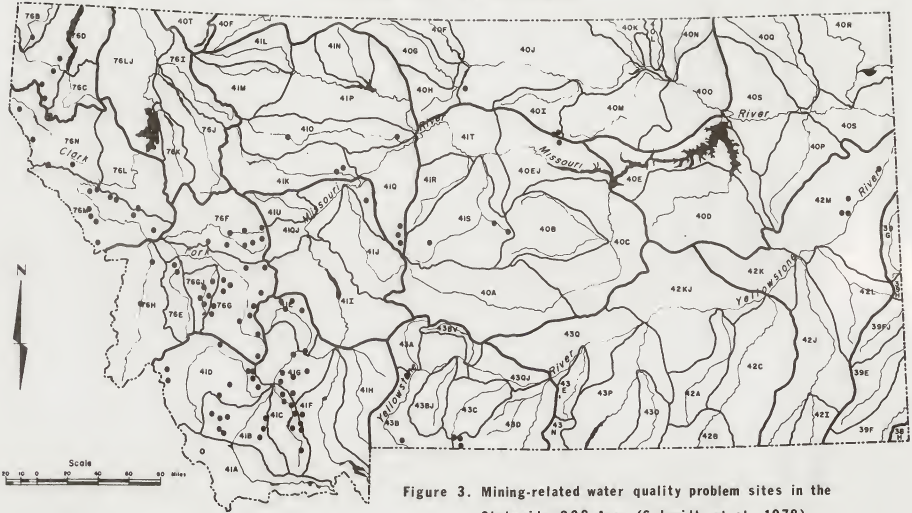


Figure 3. Mining-related water quality problem sites in the Statewide 208 Area (Schmidt, et al., 1978).

Of these 133 problems, Westech identified 18 problems as the most serious based on extent and severity of water quality impacts, length of affected streams, and extent of the mining area (Table 18). Of these major problems, 53 percent are caused principally by erosion of tailings and waste dumps, 35 percent are drainage related, and 18 percent are related to old placer workings.

Three major drainages in the Statewide 208 study area are experiencing the most significant levels of mining development. The upper Clark Fork River basin has the most hard rock operating permits (7) in the state and the most identified mining related problems, excluding placer mining. The basin contains the Anaconda Company's operations, the Black Pine Mine, and four limestone or silica mines. There are 141 small miner operations in Deer Lodge, Granite, Powell, and Silver Bow counties. Exploration activity in the basin is significant in both the Flint Creek Range and the Boulder Batholith area. Phosphate reserves are extensive around the Flint Creek Range and north of Garrison. Applications for oil and gas leasing have been received for most of the Flint Creek range.

The Beaverhead River drainage basin has five operating permits, all related to talc mining in the Ruby Range. Mineralization is high as is the potential for future development in the basin. Natural gas reserves are accessible in the Centennial Valley. Two drainages are affected by placer mining.

The Missouri River drainage, Holter Lake to Three Forks, has a number of quarry operations and several hard rock and placer mining related problems. Exploration for uranium, molybdenum, and silver is currently underway in the basin.

Silviculture--About one quarter (23 million acres) of Montana is forested. Of the forested area, an estimated 14 million acres are considered to be commercial forest and as such, have the potential to contribute nonpoint source pollution during some forest practice activity. Ownership of these commercial forest lands is shown in Table 19.

Since water quality management is supposedly an inherent aspect of the United States Forest Service's resource management planning programs, assessment of NPS pollution from silviculture activities on Forest Service lands was logically assumed to be best accomplished by that agency. Consequently, a memorandum of understanding was developed between the Forest Service and the WQB for the purpose of assessing water quality degradation on National forest lands due to silvicultural activities. Assessment of silviculture NPS pollution on remaining forested lands was accomplished through a contract with Westech. Westech's assessment was restricted to state, private, and Bureau of Land Management (BLM) lands. Other forested lands were either not within jurisdiction of the Statewide 208 project or were of small enough area not to be of major concern at this time. The following discussions are based on Westech's and the U. S. Forest Service's reports.

TABLE 18

SUMMARY OF MAJOR MINING RELATED WATER QUALITY PROBLEMS IN MONTANA STATEWIDE 208 AREA

| Mine or District | Drainage | Mine Type | Problem | Problem Status |
|---|---|---|---|---|
| Little Ben Mine | King Creek/ Peoples Creek/ Milk River | Silver-Hardrock | Erosion of tailings and deposition into stream. | No work on problem known. |
| Bannack | Grasshopper Creek/ Beaverhead River | Gold Leaf Mill Gold Placer | Erosion of old mill tailings into stream. Old hydraulic mining banks eroding. Metals and sediments problem. Approx. 24 km of stream affected. | Preliminary investigation completed. Conceptual abatement plan developed. |
| Virginia City | Browns Gulch/ Barton Gulch/ Ruby River | Gold Placer | Erosion of disturbed placer areas. Deposits and sediment in stream. | No work on problem known. |
| Crystal Mine | Uncle Sam Gulch/ Cataract Creek/ Boulder River | Silver-Hardrock | Erosion and sediment transport from pits and wastes. Acid mine discharges. Sediment, metals and acid problem. | Technical investigation completed. Legal action being taken by DHES. |
| Comet Mine | High Ore Creek/ Boulder River | Silver-Hardrock | Erosion of old mill tailings. Some acid water production. Sediment and metals problem. | Preliminary investigation completed. No further action. |
| Hughesville District Block P Mine | Dry Fork/Belt Creek/Missouri River | Silver-Hardrock | Acid mine waters from old adits and waste dumps. Metals, sulfate, acid problems. Effects extend to Belt Creek. | Technical investigation completed. Corrective measures developed; corrective progress planned but not funded. |
| Neihart District | Carpenter Creek/ Belt Creek/Missouri River | Misc.-Hardrock | Acid mine drainage from mine workings and from waste rock dumps. Metals, acidity, sedimentation problem. | No work on problem known |

| Mine or District | Drainage | Mine Type | Problem | Problem Status |
|---|---|---|---|---|
| Sand Coulee Mining Area | Sand Coulee Creek/ Missouri River | Coal-Underground | Acid mine drainage from 9 old mines. Sediment, coating of stream bottom, metals, acid problems. Extends to Missouri River. | Technical investigation completed. Corrective measures outlined. No action on corrective plan. |
| Gould Mine | Gould Creek/ Fool Hen Creek/ Canyon Creek/ Little Prickly Pear Creek | Gold-Hardrock | Acid mine drainage; erosion of waste dump | No work on problem known |
| McLaren Mine New World District | Daisy Creek/Stillwater River | Gold-Hardrock | Precipitation infiltration into wastes and disturbed areas. Acid mine drainage, metals, sediment. Daisy Creek aquatic community depressed and devoid of fish for 1.8 miles downstream from mine. | Technical investigation completed. Corrective measures developed; corrective program planned but not funded. |
| Glengary Mine New World District | Fisher Creek/ Clark Fork of Yellowstone River | Gold-Hardrock | Infiltration of precipitation into mine workings. Acid mine drainage -- metals, sulfate. | Technical investigation completed. Corrective measures developed; corrective program planned but not funded. |
| Snowshoe Mine | Snowshoe Creek/ Kootenai River | Misc.-Hardrock | Drainage from tailings contains metals; toxic to fish. | No work problem known. |
| Heddleston District Mike Horse Mine | Blackfoot River | Silver, Copper, Lead, Zinc-Hardrock | Acid mine drainage from several mines but Mike Horse Mine is major problem; tailings dam burst and deposited sediment downstream. | Reconnaisance investigation completed. No further action. |
| Elk Creek Placers | Elk Creek/ Blackfoot River | Gold Placer | Erosion of disturbed area. Erosion and deposition into stream. | No work known on problem. |

| Mine or District | Drainage | Mine Type | Problem | Problem Status |
|---|---|---|---|---|
| Forest Rose Mine | Dunkleburg Creek/ Clark Fork River | Misc.- Hardrock | Acid mine drainage; erosion of tailings; culvert plugged - additional erosion will occur. | No work on problem known. |
| Butte Mining District | Silver Bow Creek/ Clark Fork River | Copper | Effluent from mining facilities and major pollutatn input from old tailings deposits in Silver Bow Creek. Sediment, metals, sulfate problem. Stream aquatic community depressed in Silver Bow Creek. | Major correction of problem by Anaconda Company contribution completed. Additional corrective actions being investigated for stream system. |
| | Gold Creek/ Clark Fork River | Gold Placer | Erosion of disturbed areas from stream diversions and mining. | No work on problem known |
| Philipsburg District | Flint Creek | Misc.- Hardrock | Mercury from gold recovering operations in stream. Tailings erosion; adit discharges. Sediment and metals problems. | No work on problem known |

TABLE 19

OWNERSHIP OF COMMERCIAL FOREST LAND IN MONTANA

| Landowner | Acres | % of Total |
|---|---|---|
| U. S. Forest Service | 7,944,700 | 56.35 |
| BLM | 315,000 | 2.23 |
| Misc. federal | 53,000 | 0.38 |
| Indian | 620,000 | 4.4 |
| State | 421,000 | 2.99 |
| City/County | 4,700 | 0.03 |
| Private | | |
| Industrial | 1,590,000 | 11.28 |
| Individual | 3,150,000 | 22.34 |
| TOTAL | 14,098,400 | |

state, private, and BLM lands--Westech's assessment covered about one quarter of Montana's forested acreage. Three industries, Burlington Northern, Champion, and St. Regis, own 11 percent of Montana's commercial forest lands. These industries accounted for 30 percent of all the timber harvested in Montana in 1976. Harvested volumes from industrial lands increased from 194 to 339 million board feet between 1970 and 1976. An estimated 19,000 individuals own over 22 percent of Montana's commercial forests. These lands accounted for 21 percent of the state's total harvest in 1976. The State of Montana controls about three percent of the commercial forests. The Forestry Division of the Department of Natural Resources and Conservation administers these lands, but decisions are made by the Board of Land Commissioners. Since 1974, state forest lands have supplied about one percent of the total timber harvest. The BLM is the only other major federal owner of forest lands besides the Forest Service. Since 1974, BLM lands have accounted for less than one percent of the state's total timber harvest.

Westech identified a total of 183 known, suspected, or anticipated water quality problem areas related to silviculture activities in the Statewide 208 area. Due to the nature of nonpoint source pollution and lack of adequate stream monitoring systems, many reported problems were difficult or impossible to document. In many cases, silviculture activities were one of several concurrent land uses in a particular watershed making it difficult to specifically quantify the effects of the timber-use activity. A major general problem identified by Westech was that of checkerboard ownership. In many basins, independent and simultaneous forest activities of several owners cause more disturbance than if those activities had been coordinated.

Table 20 identifies watersheds which are currently being adversely affected by silviculture activities; problem areas are shown in Figure 4.

Those watersheds currently the most severly degraded as the result of forest activities include: Fisher River, Shields River, Fish Creek (tributary to Clark Fork River), Thompson River, Tobacco River, and the Smith River.

Four major drainage basins were found to have significant silviculture NPS problems and are discussed below. In most cases, particularly in areas of checkerboard ownership, it was not possible to determine which forest ownership was responsible for the degradation.

1) Kootenai River Basin--This basin lies in the northwest corner of Montana. Headwaters of the Kootenai River are on the Columbia River in British Columbia. Approximately 2.3 million acres of the Kootenai Basin's 2.4 million acres are forested. About 53 percent of the forest are of commercial value. The USFS is the largest single landowner. Slope and soil conditions are the primary limiting factors in the basin. Glacial till and glaciofluvial and glaciolacustrine deposits occur in narrow valleys and steep slopes. Timber production is extensive on these soils which present a severe erosion hazard when mismanaged.

TABLE 20

SILVICULTURE-RELATED WATER QUALITY PROBLEMS ON STATE AND PRIVATE FOREST LANDS IN THE STATEWIDE 208 STUDY AREA

Upper Kootenai River Drainage

| Drainage Basin | County | Stream Affected | Reported type of Impact | Reported Cause of Impact |
|---|---|---|---|---|
| (1) 76D | Lincoln | Dodge Creek (perennial) | High sediment load; change in flow regime; unstable banks | Poor road design (lack of drainage structures), poor road location (caused stream diversion); cumulative effect of harvests within drainage; slash debris in stream |
| (2) 76D | Lincoln | Pinkham Creek (perennial) | High sediment load; change in flow regime; unstable banks | Poor road design (lack of drainage structures), poor road maintenance; cumulative effects of harvests within drainage; steep slope and erosive soil conditions |
| (3) 76D | Lincoln | Young Creek (perennial) | High sediment loads; increased water yield | Heavily roaded; large area harvested; inadequate coordination of harvest activities between ownerships |
| (4) 76D | Lincoln | Tobacco River & Fortine Creek (perennial) | Bank degradation; increased sediment load; flow alterations | Log transport in river (1920-30's); stream channelization (railroad construction); extensive harvesting in drainage |
| (5) 76D | Lincoln | Meadow Creek (perennial) | Increased sediment yield; alteration of flow regime | Poor road construction; skidding in stream channel; logging debris left in stream channel; logging debris left in channel |
| (6) 76D | Lincoln | Deep Creek (perennial) | Increased sediment load; alteration of flow regime | Harvest activities within stream channel; logging debris left in channel |

TABLE 20, Continued

| Drainage Basin | County | Stream Affected | Reported type of Impact | Reported Cause of Impact |
|---|---|---|---|---|
| (7) 76D | Lincoln | Swamp Creek (perennial) | Increased sediment load; bank instability | Harvest activities within and immediately adjacent to stream |
| (8) 76C | Flathead & Lincoln | Pleasant Valley Creek (perennial) | Increased water yield and associated sedimentation | Extensive harvesting and road construction (also grazing) |
| (9) 76C | Flathead | Pleasant Valley Fisher River (perennial) | Increased water yield and associated sedimentation | Extensive harvesting; poor road design (steep grades, no erosion controls); grazing |
| (10) 76C | Lincoln | Middle Fisher Rv. (U.S. Highway #2) to Wolf Creek (perennial) | High sediment load | Stream cutting its banks (due to channelling and increased water yield) |
| (11) 76C | Lincoln | Lower Fisher Rv. (Wolf Creek to mouth)(perennial) | High sediment | Stream cutting its banks (due to channelling and increased water yield) |
| (12) 76C | Lincoln | Wolf Creek (perennial) | High sediment load increased water yields; temperature increase | Extensive harvesting; (channelizing from railroad construction) |
| (13) 76D | Lincoln | North Fork Keeler Creek (perennial) | Flooding, channel adjustments, sedimentation | Extensive harvest; poor road management |
| (14) 76D | Lincoln | Iron Creek (perennial) | High sediment load | Poor road design and maintenance |
| (15) 76D | Lincoln | Lake Creek (perennial) | Periodic high sediment loads, silting in reservoir at at Troy Dam (primarily from Iron Creek and Keeler Creek) | Extensive harvests in watershed, poor road design and maintenance |
| (16) 76D | Lincoln | Blue Creek (perennial) | Erosion and sedimentation | Poor road design (inadequate drainage); steep slope logging, skidded in stream |

TABLE 20, Continued

| Drainage Basin | County | Stream Affected | Reported type of Impact | Reported Cause of Impact |
|---|---|---|---|---|
| (17) 76B | Lincoln | Wampoo Creek (perennial) | Siltation; change in channel geometry (no defined channel); (may significantly affect Yaak River) | Skidded on steep slopes and across streams; poor road design and maintenance; debris in stream |
| (18) 76B | Lincoln | East Fork Yaak River (perennial) | Erosion | Gully channels created by skidding; slash debris in stream |
| (19) 76G | Lewis & Clark | Hope Creek (perennial) | Sedimentation; possible water yield increases | Road construction, clearcut harvesting |
| (20) 76G | Lewis & Clark | Dog Creek (perennial) | Sedimentation; possible water yield increase | Road construction; clearcut harvesting |
| (21) 76G | Powell | Telegraph Creek (perennial) | Sedimentation; channel impacts and instability | Streamside harvest activities; debris in stream; channel rehabilitation |
| (22) 76G | Powell & Deer Lodge | Peterson Creek (perennial) | Sedimentation; channel impacts | Road construction; lack of erosion control measures |
| (23) 76G | Deer Lodge | Perkins Gulch (perennial) | Soil movement; sedimentation | Road construction; improper skid trails |
| (24) 76G | Missoula | Deer Creek (perennial) | Increased sediment loads | Road construction; clearcut harvesting |
| (25) 76G | Deer Lodge | Mill Creek (perennial) | High sediment loads; channel degradation | Initial logging and subsequent lack of vegetation (fire, fume kills) |
| (26) 76G | Powell | Little Blackfoot River (perennial) | Not defined by DF&G | Watershed abuse due to logging |
| (27) 76F | Lewis & Clark | Keep Cool Creek (perennial) | Minor sedimentation; possible increased water yields; soil movement | Extensive clearcut |

TABLE 20, Continued

| Drainage Basin | County | Stream Affected | Reported type of Impact | Reported Cause of Impact |
|---|---|---|---|---|
| (28) 76F | Lewis & Clark | Beaver Creek (perennial) | High sediment load | Extensive roads and harvests; steep gradient of stream |
| (29) 76F | Powell | Arrastra Creek (intermittant) | Excessive soil disturbance; sedimentation | Heavily logged (lack of coordination with adjacent mixed ownership); poor road construction; poor skidding practices |
| (30) 76F | Lewis & Clark | Landers Fork and North | High sediment load; unstable stream-banks; soil movement | Logging practices, grazing practices, and a natural fire |
| (31) 76F | Lewis & Clark | Hogum Creek (perennial) | Possible accelerated erosion | Harvested on steep slopes |
| (32) 76F | Missoula | Gold Creek | Increased water yield probable; sedimentation | Large areas of harvest, extensive road building (over last 30 years) |
| (33) 76F | Missoula | Belmont Creek (perennial) | Increased water yield probable; sedimentation | Large areas of harvest, extensive road building (over last 30 years) |
| (34) 76F | Missoula | Blackfoot River (mainstem)(perennial) | Not defined by DF&G | Watershed abuse due to logging |
| (35) 76F | Powell | Monture Creek (perennial) | Not defined by DF&G | Watershed abuse due to logging practices |
| (36) 76F | Lewis & Clark | Alice Creek (perennial) | Mud slide washing into stream, high sediment load | Improper placement of logging road |
| (37) 76F | Lewis & Clark | Blackfoot River (perennial) | Accelerated erosion | Poor skidding practices in steep terrain |
| (38) 76F | Powell | Nevada Creek (perennial) | Not defined by DF&G | Watershed abuse due to logging |
| (39) 76F | Missoula | Twin Creeks (perennial) | Sedimentation; alteration of flow regime | Extensive harvest and road construction activities |

TABLE 20, Continued

| Drainage Basin | County | Stream Affected | Reported type of Impact | Reported Cause of Impact |
|---|---|---|---|---|
| (40) 76F | Powell | Chamberlain Creek (perennial) | High sediment loads | Past logging (1950's) and subsequent over-grazing |
| (41) 76F | Lewis & Clark | Willow Creek (perennial) | Sediment contribution | Poor road construction |
| (42) 76F | Missoula | West Fork Clearwater River (perennial) | High sediment loads; increased water yields; channel degradation | Extensive harvesting and road construction |
| (43) 76F | Missoula | Deer Creek (perennial) | High sediment loads; increased water yields; channel degradation | Extensive harvesting and road construction |
| (44) 76F | Missoula | Richmond Creek (perennial) | High sediment loads; increased water yields; channel degradation | Extensive harvesting and road construction |
| (45) 76F | Missoula | Placid Creek (perennial) | Sedimentation, other impacts to Placid Lake | Harvesting and road construction; water diversion associated with Jocko reservoirs |
| (46) 76F | Missoula | Lost Prairie Creek (perennial) | High sediment loads; increased water yields; channel degradation | Extensive harvesting and road construction |
| (47) 76F | Powell and Missoula | Morrel Creek (perennial) | High sediment loads; increased water yields; channel degradation | Extensive harvesting and road construction |
| (48) 76F | Missoula | Blanchard Creek (perennial) | Increased sediment loads | Harvesting and road construction |
| (49) 76GH | Granite | Douglas Creek (perennial) | Watershed abuse | Not delineated (DF&G) |
| (50) 76GJ | Granite | Boulder Creek (perennial) | Watershed abuse | Not delineated (DF&G) |

TABLE 20, Continued

| Drainage Basin | County | Stream Affected | Reported type of Impact | Reported Cause of Impact |
|---|---|---|---|---|
| (51) 76H | Ravalli | Sleeping Child Area (Cameron, Martin, Rye, Lyman and Bertie Lord Creeks) (perennial) | Sedimentation; increased water yield; channel degradation (effects still felt in lower reaches) | Natural fire and timber harvests |
| (52) 76H | Ravalli | Moose Creek (perennial) | Sedimentation | Road construction in natural hazard area |
| (53) 76H | Ravalli | Claremont & Haacke Creeks (perennial) | Soil movement; sedimentation | Harvest practices; steep slopes; soil type |
| (54) 76H | Ravalli | Ambrose Creek (perennial) | Sedimentation; channel degradation | Road construction; logging in stream; debris in stream |
| (55) 76M | Missoula | Sixmile Creek (perennial) | High sediment load; flooding | Large area harvested (non-coordination between ownerships) |
| (56) 76M | Missoula | Petty Creek (perennial) | High sediment loads | Harvest and road building activities; other land uses (development, grazing) |
| (57) 76M | Missoula, Mineral, Sanders | Clark Fork River (perennial) | Not defined by DF&G | Watershed abuse due to logging |
| (58) 76M | Missoula | Mill Creek (perennial) | High sediment load; channel degradation | Extensive harvest; road construction; non-coordination of management activities between mixed ownerships |
| (59) 76M | Missoula | Rattlesnake Creek (perennial) | Not defined by DF&G | Past logging resulting in general watershed abuse |
| (60) 76M | Missoula | Deep Creek (perennial) | High sediment loads; increased water yields; channel degradation | Extensive harvest and road construction debris in streams |

TABLE 20, Continued

| Drainage Basin | County | Stream Affected | Reported type of Impact | Reported Cause of Impact |
|---|---|---|---|---|
| (61) 76M | Missoula | Ninemile Creek (perennial) | Severe erosion, sedimentation, and habitat deterioration | Combined abuse of watershed (logging, dredge mining, road construction) |
| (62) 76M | Mineral | Fish Creek (perennial) | High sediment loads | Road construction; extensive harvest; other poor logging practices |
| (63) 76M | Mineral | Thompson Creek (perennial) | High sediment load; flooding; channel degradation | Road construction; streamside harvest; improper skidding; poor road design and maintenance (drainage problems) |
| (64) 76M | Mineral | Deer Creek (perennial) | High sediment load; flooding; channel degradation | Placement of log landing in creek |
| (65) 76M | Mineral | Bear Creek (perennial) | High sediment load; flooding; channel degradation | Poor road design and maintenance (inadequate drainage and erosion structures) |
| (66) 76N | Sanders | Elk Creek (perennial) | Sedimentation; channel alteration | Skidding logs in stream; felling logs in stream; some channelization |
| (67) 76N | Sanders | Weeksville Creek (perennial) | Channel modifications; sedimentation | Streamside road construction; skidding in stream |
| (68) 76N | Sanders | Dry Creek (perennial) | Channel modifications | Streamside harvests; skidding logs in streambed |
| (69) 76N | Sanders | Clark Fork River | General impacts of harvesting (low to moderate) | Cumulative effects of USFS and other harvest activities |
| (70) 76N | Sanders | Thompson River (perennial) | High sediment loads; channel degradation | Extensive harvest; streamside road location; steep area harvested |
| (71) 76N | Sanders | Little Thompson River (perennial) | Not defined by DF&G | Watershed abuse due to logging |

TABLE 20, Continued

| Drainage Basin | County | Stream Affected | Reported type of Impact | Reported Cause of Impact |
|---|---|---|---|---|
| (72) 76N | Sanders | Lazier Creek (perennial) | High sediment load; increased water yield | Extensive harvest in basin |
| (73) 76N | Sanders | Fishtrap Creek (perennial) | Potential for further degradation (present USFS impacts) | Additional forestry activities without coordinated planning between ownerships |
| (74) 76N | Sanders | McGregor Creek (perennial) | Sedimentation | Construction and silvicultural activities |
| (75) 76K | Missoula | Swan River (perennial) | Not defined by DF&G | Watershed abuse due to logging practices |
| (76) 41D | Beaverhead | Nugget Creek and Pioneer Creek (perennial) | Sedimentation; channel alteration | Logging debris in stream; skidding across stream; streamside harvesting |
| (77) 41A | Beaverhead | Winslow Creek & Tipton Creek (perennial) | Accelerated erosion | Excessive soil disturbance due to harvesting in wet soil conditions |
| (78) 41A | Beaverhead | Bloody Dick Creek (perennial) | Increased sediment load; channel alteration | Road construction (steep gradient, poor drainage structures, stream crossing) |
| (79) 41C | Madison | Idaho Creek (perennial) | Sediment increases | Streamside harvest; debris in stream |
| (80) 41B | Beaverhead | St. Louis Creek (perennial) | Increased sediment load; channel degradation | Logging debris in stream channel |
| (81) 41E | Jefferson | Headwaters area of several streams | Physical damage to channel; accelerated erosion | Felling and skidding in streams |
| (82) 41I | Broadwater | Duck Creek (& general area) (perennial & ephemeral) | Possible accelerated erosion | Road construction |
| (83) 41I | Broadwater | Gabish Gulch (ephemeral) | Sedimentation; channel impacts | Road located in stream bottom |

TABLE 20, Continued

| Drainage Basin | County | Stream Affected | Reported type of Impact | Reported Cause of Impact |
|---|---|---|---|---|
| (84) 41I | Lewis & Clark | East Skelly Gulch (perennial) | Sedimentation; channel impacts | Streamside harvest; logging across stream |
| (85) 41QJ | Lewis & Clark | Wolf Creek (perennial) | Sedimentation; channel impacts | Logging debris in stream (possibly complicated by streamside grazing activity) |
| (86) 41QJ | Lewis & Clark | Rattlesnake Creek and Mill Creek (perennial) | Possible accelerated erosion | Generally poor harvest practices |
| (87) 41QJ | Lewis & Clark | South Fork Stickney Creek (perennial) | Not defined by DF&G | Watershed abuse due to logging practices |
| (88) 41Q | Cascade | Belt Creek (perennial) | Not defined by DF&G | Watershed abuse due to logging practices |
| (89) 41I | Jefferson | Buffalo Creek (perennial) | Accelerated erosion; possible water yield increase | Clear-cut on steep slopes; inadequate road drainage and grade |
| (90) 41I | Jefferson | Middle Fork Warm Springs Creek | Possible accelerated erosion | Poor road construction |
| (91) 41U | Lewis & Clark | Green Creek (perennial) | Accelerated erosion | Road construction (steep slopes, erosive soil conditions) |
| (92) 41U | Lewis & Clark | Middle Fork Dearborn River (perennial) | Accelerated erosion | Road construction (steep slopes, erosive soil conditions) |
| (93) 41J | Meagher | Benton Gulch (perennial) | Not defined by DF&G | Watershed abuse due to logging practices (may possibly relate to USFS land) |
| (94) 41J | Meagher | Newland Creek (perennial) | Not defined by DF&G | Watershed abuse due to logging practices (probably extensive clearcut harvests) |

TABLE 20, Continued

| Drainage Basin | County | Stream Affected | Reported type of Impact | Reported Cause of Impact |
|---|---|---|---|---|
| (95) 41J | Meagher | North Fork Smith River (perennial) | Stream channel degradation; sedimentation | Extensive clearcut harvesting |
| (96) 41J | Meagher | Sheep Creek (perennial) | Stream channel degradation; sedimentation | Extensive clearcut harvesting; road construction (channelized stream segments) |
| (97) 41J | Meagher & Cascade | Smith River (perennial) | Not identified by DF&G | Watershed abuse due to logging practices |
| (98) 41J | Meagher | Moose Creek (perennial) | Possible sedimentation | Clearcut harvest along streambanks |
| (99) 41J | Meagher | Thompson Gulch (perennial) | Possible sedimentation | Clearcut harvest along streambanks |
| (100) 41J | Meagher | Elk Creek (perennial) | Possible sedimentation | Poor road construction |
| (101) 41J | Meagher | Beaver Creek (perennial) | Sedimentation | Numerous stream crossings |
| (102) 41S | Fergus | Big Springs Creek (perennial) | Sedimentation; decreased oxygen; increased streamflow | Logging and associated road construction |
| (103) 41S | Judith Basin | Judith River headwaters (perennial and ephemeral) | High sediment load | Poor logging practices |
| (104) 40A | Meagher | Forest Lake | Sedimentation; increased water yield | Large areas harvested; poor road construction |
| (105) 40B | Fergus | N. Fork Flatwillow Creek/ S. Fork Flatwillow Creek | Not defined by DF&G | Watershed abuse due to logging practices |
| (106) 40A | Meagher | Cottonwood Creek (perennial) | Sedimentation; possible water yield increases | Extensive harvest in headwaters area |
| (107) 43B | Park | Bassett Creek (perennial) | High sediment load | Naturally unstable area (erosive volcanic material - Tertiary) |

TABLE 20, Continued

| Drainage Basin | County | Stream Affected | Reported type of Impact | Reported Cause of Impact |
|---|---|---|---|---|
| (108) 43B | Park | Cedar Creek (perennial) | High sediment load | Naturally unstable area (erosive volcanic material - Tertiary) |
| (109) 43B | Park | Stoughten Creek (perennial) | High sediment load; increased water yield | Naturally unstable area; impact aggravated by poor road design and construction; skidding logs in stream |
| (110) 43B | Park | Donahue Creek (perennial) | High sediment load; increased water yield | Naturally unstable area; impact aggravated by harvest activities |
| (111) 43B | Park | Little Donahue Creek (perennial) | High sediment load; increased water yield | Naturally unstable area; impact aggravated by harvest activities |
| (112) 43B | Park | Fridley Creek (perennial) | High sediment load; increased water yield | Naturally unstable area; impact aggravated by harvest activities |
| (113) 43B | Park | Pine Creek (perennial) | High sediment load; increased water yield | Poor road location; poor stream crossings |
| (114) 43B | Park | Trail Creek (perennial) | High sediment load; increased water yield | Poor road location; poor stream crossings; harvesting along streams |
| (115) 43B | Park | Morrison Gulch (perennial) | High sediment load; increased water yield | Poor road location; poor stream crossings; harvesting along streams |
| (116) 43B | Park | S. Fork Deep Creek (perennial) | High sediment load; increased water yield | Poor road location; poor stream crossings; harvesting along streams |
| (117) 43B | Park | Rock Creek (perennial) | High sediment load; increased water yield | Naturally unstable area; impacts aggravated by extensive timber harvesting |
| (118) 43B | Park | Tom Miner Creek (perennial) | High sediment load; increased water yield | Naturally unstable area; impacts aggravated by extensive timber harvesting and grazing |

TABLE 20, Continued

| Drainage Basin | County | Stream Affected | Reported type of Impact | Reported Cause of Impact |
|---|---|---|---|---|
| (119) 43A | Gallatin & Park | Brackett Creek (perennial) | Increased water yield; high sediment load; channel adjustments | Large area of timber harvested |
| (120) 43A | Gallatin | Skunk Creek (perennial) | Increased water yield; high sediment load; channel adjustments | Large area of timber harvested; road along creek |
| (121) 43A | Meagher & Park | Shields River (upper reaches) (perennial) | Increased water yield; high sediment load; channel adjustments; high nutrient levels | Road construction; large area of timber harvested |
| (122) 43A | Park | Shields River (lower reaches) (perennial) | Channel adjustments; high sediment load | Combined abuse of watershed (forestry, agriculture) |
| (123) 43A | Park | Horsefly Creek (perennial) | High sediment load | Road construction |
| (124) 43A | Park | Middle Fork Pitch Creek (perennial) | High sediment load | Road construction |
| (125) 43A | Park | Cottonwood Creek (perennial) | High sediment load | Road construction |

## STATE OF MONTANA

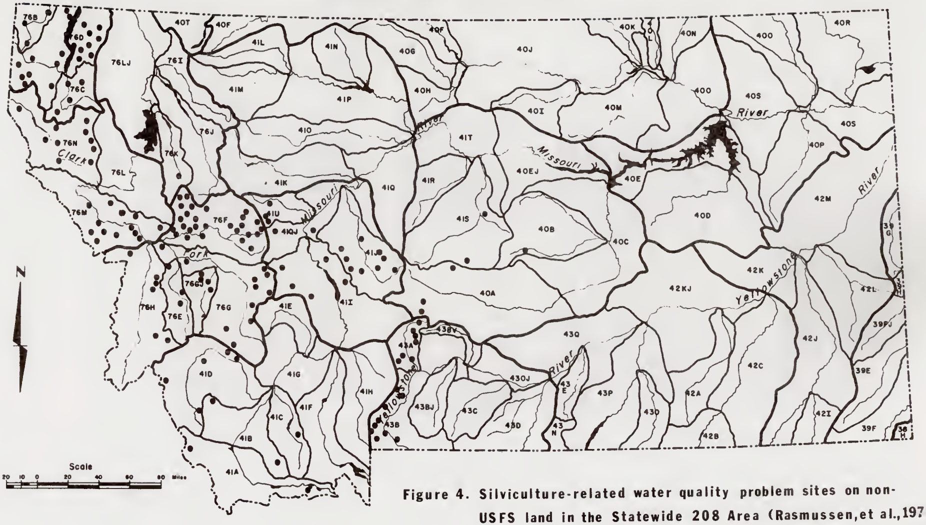


Figure 4. Silviculture-related water quality problem sites on non-USFS land in the Statewide 208 Area (Rasmussen,et al.,1978).

2) <u>Clark Fork River Basin</u>--The Clark Fork River is a tributary of the Columbia River and receives water from most of Montana west of the Continental Divide. In the upper portion of the basin, from headwaters to the north of the Blackfoot River, much of the timberland is administered by the USFS. On non-USFS lands, agriculture, mining, and urbanization add to silvilculture NPS problems. The middle portion of the Clark Fork River Basin, from the mouth of the Blackfoot River to the Flathead River Confluence, receives water from large forested areas. Again, the USFS is the major landowner. The lower portion of the Clark Fork River Basin begins at the mouth of the Flathead River and extends to the Idaho state line. USFS ownership dominates the basin except in the Thompson River drainage.

3) <u>Missouri River Basin</u>--Timber harvesting trends have been gradually changing in the upper Missouri River Basin. Initially, most harvesting occurred on USFS lands; however, private timber resources are currently supplying 75 percent of the production. Though USFS ownership dominates the middle Missouri River Basin, Burlington Northern, Champion, and several large ranch companies own significant portions. Some water quality impacts are minimized due to dry climatic conditions in the basin. On the other hand, others are aggravated due to slow regeneration rates on some sites. Commercial timber resources of the lower Missouri River Basin are primarily limited to the Musselshell and Judith River basins headwater areas.

4) <u>Yellowstone River Basin</u>--The upper Yellowstone River basin lies in southcentral Montana and is the only segment of the basin within the Statewide 208 area. Most forested land is owned either by USFS or BN along with significant small private holdings. There are also scattered BLM and state ownerships. Much of the private land was harvested ten years ago but some merchantable timber still remains in most drainages. Several drainages have experienced extensive clear and selective cutting.

Planned forest development activities are shown in Table 21. Planning of these activities does not mean water quality problems will ultimately result from every acre affected or road constructed. The figures do indicate the magnitude of opportunities for water quality problem development. Table 22 lists specific drainages where additional problems may be created or existing problems aggravated by intensified silvicultural activities.

U. S. Forest Service lands--National Forest boundaries in Montana encompass nearly 20,000,000 acres (Table 23). Although National Forests are managed under the multiple use concept, timber resource management dominates each forest's planning program. Acreage of productive timber lands are shown in Table 24.

Timber harvest is big business in western Montana. The harvest in FY 1976 totalled over 444.1 million board feet (MMBF) (Table 25) and was valued at nearly $15 million. Figures for FY 1977 show substantial increases over 1976, but are still far below 1966 when the Montana forests produced 714.3 MMBF. Logging was carried out on 33,035 acres in 2,096 timber sales during

TABLE 21

PLANNED SILVICULTURAL ACTIVITIES

| Landowner | Comm. Forest Base | Acres Affected In Next 10 Years (Estimated) | Road Construction | Herbicides Fertilizers | Estimated Cut (Annual) MMBF | Principal Harvesting Method |
|---|---|---|---|---|---|---|
| BLM | 315,000 | 60,000-70,000 | <5 miles/yr. | Minimal Use | 14 | Selection Cutting |
| State | 421,000 | 85,000-100,000 | 12-16 miles/yr. | Minimal Use | 21 | Selection Cutting |
| Large Private | 1,590,000 | 500,000-750,000 | 500-700 miles next 5/yrs. | Minimal Use | 300-400 | Selection, Shelter, Wood, Seed, Tree, Salvage |
| Small Private | 3,150,000 | 250,000-400,000 | Unknown | Minimal Use | 150-250 | Variable |

TABLE 22

POTENTIAL SILVICULTURE-RELATED PROBLEM AREAS ON STATE AND PRIVATE FOREST LANDS IN THE STATEWIDE 208 AREA

| Drainage Basin | County | Stream Affected | Possible Impact | Cause of Impact |
|---|---|---|---|---|
| **Upper Kootenai River Drainage** | | | | |
| (1) 76D | Lincoln | Kootenai River & tributaries | Aggravation of existing problems; aggravation of naturally erosive conditions | Further harvesting activities; inadequate site planning in critical areas |
| (2) 76D | Lincoln | Kootenai River & tributaries | Creation of similar problems in other drainages | Lack of coordination in planning activities between mixed ownerships |
| **Tobacco River Drainage** | | | | |
| (3) 76D | Lincoln | Meadow Creek & tributaries | Increased sediment load; increase in water yield | Continuing harvest on small ownerships (some for subdivision) |
| **Fisher River Drainage** | | | | |
| (4) 76C | Lincoln | East Fisher Creek and Silver Butte Creek (perennial) | Potential impact | Potential for poorly coordinated land management in checkerboard ownership |
| (5) 76C | Lincoln | Wolf Creek (perennial) | Potential impact | Potential for poorly coordinated land management in checkerboard ownership |
| (6) 76C | Lincoln & Flathead | Fisher River watershed | Complicate existing impacts | |
| **Lower Kootenai River Drainage** | | | | |
| (7) 76D | Lincoln | Pipe Creek (perennial | Potential problem | Uncoordinated management activities on multiple ownerships |

TABLE 22, Continued

| Drainage Basin | County | Stream Affected | Possible Impact | Cause of Impact |
|---|---|---|---|---|
| (8) 76D | Lincoln | O'Brien Creek (perennial) | Potential problem (municipal water supply) | Uncoordinated management activities on multiple ownerships |
| (9) 76D | Lincoln | Flower Creek (perennial) | Potential problem (municipal water supply) | Uncoordinated management activities on multiple ownerships |
| (10) 76D | Lincoln | Brush Creek & Ruby Creek (perennial) | Potential problem | Uncoordinated management activities on multiple ownerships |
| (11) 76B | Lincoln | Yaak River (perennial) | Potential sedimentation | Streamside harvesting |
| (12) 76B | Lincoln | Yaak River (watershed) | Potential sedimentation | Streamside harvesting |
| | | Mainstem Clark Fork River Drainage (Upper) | | |
| (13) 76G | Deer Lodge | Lost Creek (perennial | Potential problem (large area of commercial timber under contract) | Extensive harvest and road construction without use of BMP's may create impacts |
| (14) 76G | Powell | Trout Creek (perennial) | Possible problems | Numerous harvests |
| (15) 76G | Granite | Tributaries to Clark Fork River (perennial and ephemeral) | Potential problem | Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse |
| | | Blackfoot River Drainage | | |
| (16) 76F | Powell | Nevada Creek tributary (perennial) | Possible accelerated erosion | Harvested on steep slopes adjacent to stream; improper skidding practices |
| (17) 76F | Lewis & Clark | South Fork Blackfoot River (perennial) | Potential for sedimentation increased water yield | Non-coordination of forestry activities in area of mixed ownership; may lead to watershed abuse |

TABLE 22, Continued

| Drainage Basin | County | Stream Affected | Possible Impact | Cause of Impact |
|---|---|---|---|---|
| (18) 76F | Missoula | Elk Creek (perennial) | Possible problem | Mainly due to mining but may be some effects of harvesting |
| (19) 76F | Missoula | Bear Creek (perennial) | Possible problems | Extensive harvest and road construction |
| (20) 76F | Lewis & Clark | Lincoln Gulch (ephemeral) | Suspect accelerated erosion | High road density; improper skidding practices in steep terrain |
| (21) | Lewis & Clark | Sucker Creek (ephemeral) | Possible sediment contribution | Old gullied skid trails |
| (22) 76F | Missoula | Boles Creek (perennial) | Potential for sedimentation; increased water yield; impacts to Placid Lake | Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse; logging in Boles Creek is starting (BN, USFS) |
| (23) 76F | Missoula | Clearwater River watershed | Potential for sedimentation; increased water yield; complication of existing impacts | Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse |
| | | Flint Creek Drainage | | |
| (24) 76GJ | Granite | Cow Creek (perennial) | Potential problem | Uncoordinated activities occurring on multiple ownership |
| (25) 76GJ | Granite | Willow Creek (perennial) | Potential problem | Uncoordinated activities occurring on multiple ownership |
| | | Rock Creek Drainage | | |
| (26) 76E | Granite | Upper Willow Creek (perennial) | Possible channel impacts and sedimentation | Streamside harvest activities |

TABLE 22, Continued

| Drainage Basin | County | Stream Affected | Possible Impact | Cause of Impact |
|---|---|---|---|---|
| (27) 76E | Granite | Rock Creek (perennial) | Possible channel impacts and sedimentation | Streamside harvest activities |
| (28) 76E | Missoula | Gilbert Creek (perennial) | Potential for sedimentation increased water yield | Non-coordination of forestry activities in area of mixed ownership; may lead to watershed abuse |
| | | Bitterroot River Drainage | | |
| (29) 76H | Ravalli & Missoula | Bitterroot River watershed | Potential for sedimentation; increased water yield | Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse |
| (30) 76H | Missoula | Lolo Creek (perennial) | Potential for sedimentation; increased water yield | Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse |
| (31) 76H | Ravalli | Burnt Fork Creek (perennial) | Potential for sedimentation; increased water yeidl | Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse (municipal water supply) |
| (32) 76M | Missoula, Mineral, Sanders | Clark Fork River and tributaries | Potential problems (sedimentation, increased water yield, channel degradation) | Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse |
| (33) 76M | Missoula | Albert Creek (perennial) | Possible existing or future impacts | Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse |
| (34) 76M | Missoula | Rock Creek (perennial) | Possible existing or future impacts | Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse |

TABLE 22, Continued

| Drainage Basin | County | Stream Affected | Possible Impact | Cause of Impact |
|---|---|---|---|---|
| | | Fish Creek Drainage | | |
| (35) 76M | Mineral | Fish Creek watershed | Potential for additional sedimentation, increased water yield | Non-coordination of forestry activities in area of mixed ownership; continued poor practices |
| | | Main Stem Clark Fork River Drainage (Lower) | | |
| (36) 76N | Sanders | White Pine Creek (perennial) | Potential erosion and sedimentation | Streamside harvest; logging debris piled along stream |
| (37) 76N | Sanders | Vermillion River (perennial) | Potential problem | Non-coordination of forestry activities between ownerships |
| | | Thompson River Drainage | | |
| (38) 76N | Sanders | Thompson River & tributaries (perennial) | Further watershed abuse and water quality degradation | Extensive harvest and road construction without coordination between land owners |
| (39) 76K | Missoula | Swan River & tributaries | Potential for sedimentation; increased water | Non-coordination of forestry activities in area of mixed ownership may lead to watershed abuse |
| | | Big Hole River Drainage | | |
| (40) 41D | Beaverhead | Bull Creek (perennial) | Potential problem | Extensive harvest in area |
| (41) 41D | Beaverhead | Unnamed ephemeral stream | Potential problem | Logging debris in channel; skidded across drainages; streamside harvesting |
| (42) 41D | Deer Lodge | California and Oregon Creeks (perennial) | Potential problem | Naturally erosive soil conditions; could be complicated by timber harvest and road building |

TABLE 22, Continued

| Drainage Basin | County | Stream Affected | Possible Impact | Cause of Impact |
|---|---|---|---|---|
| (43) 41D | Deer Lodge | Drainages in area of Mt. Haggin land purchase (DF&G) (perennial and ephemeral) | Potential problem | Extensive harvest activities |
| | | Red Rock River Drainage | | |
| (44) 41A | Beaverhead | Medicine Lodge Creek (perennial) | Potential problem | Uncoordinated harvest activities |
| (45) 41A | Beaverhead | Red Rock River drainage | Potential problem | Uncoordinated or poorly planned activities in critical areas |
| | | Ruby River Drainage | | |
| (46) 41C | Madison | Noble Fork of Wisconsin Creek (perennial) | Potential problem | Streamside harvest |
| (47) 41C | Madison | Ruby River and tributaries | Potential for increased sediment loads and other impacts | Naturally unstable areas; activities could aggravate situation |
| (48) 41B | Beaverhead | Blacktail Deer Creek (perennial) | Potential problems | Uncoordinated harvest activities which may accelerate erosion in sensitive areas (poorly consolidated sediments) |
| | | Jefferson River Drainage | | |
| (49) 41G | Jefferson | Headwaters (Whitehall Creek) (perennial) | Potential problem | Non-coordinated harvest activities; possible critical area |
| (50) 41G | Madison | Wyckham Creek, Spring Creek, and Mill Creek (Perennial) | Potential problem | Non-coordinated harvest activities; possible critical area |

TABLE 22, Continued

| Drainage Basin | County | Stream Affected | Possible Impact | Cause of Impact |
|---|---|---|---|---|
| | | **Boulder River Drainage** | | |
| (51) 41E | Jefferson | Headwaters of Dry Creek | Potential problem | Non-coordination of harvest activities between mixed ownership |
| (52) 41E | Jefferson | Headwaters area of several streams | Potential problem (extensive harvest) | Non-coordination of harvest activities between mixed ownership |
| | | **Rocky Mountain Front Drainages** | | |
| (53) 41U | Lewis & Clark | Dearborn River | Potential problem (accelerated erosion) | Non-coordination of harvest and road building activities among mixed ownership |
| | | **Smith River Drainage** | | |
| (54) 41J | Meagher & Cascade | Smith River & tributaries | Aggravation of existing problems; creation of similar problems in other drainages | Continued use of poor forestry practices (and agricultural practices) in an uncoordinated manner |
| | | **Judith River Drainage** | | |
| (55) 41S | Judith Basin & Fergus | Judith River headwaters | Potential problem | Future harvest potential |
| (56) 40A | Wheatland | Roberts Creek (ephemeral) | Potential problem | Future harvest potential |
| | | **Upper Yellowstone River Drainage** | | |
| (57) 43B | Park | Upper Yellowstone River Drainage (and tributaries) | Aggravation of existing problems; creation of similar problems in other drainages | Continued harvesting activities in critical areas without coordination between land managers |

TABLE 22, Continued

| Drainage Basin | County | Stream Affected | Possible Impact | Cause of Impact |
|---|---|---|---|---|
| | | Shields River Drainage | | |
| (58) 43A | Park, Gallatin, | Shields River and tributaries | Aggravation of existing problems; creation of similar problems in other drainages | Continued use of poor forestry practices (and agricultural practices) in an uncoordinated manner |

TABLE 23

ACREAGES OF THE NATIONAL FOREST IN MONTANA TAKEN FROM THE ANNUAL STATISTICAL REPORT OF NATIONAL FOREST AREAS, 1976.[a]

| National Forest | Area (Net) (Acres) | Area (Others)[b] (Acres) | Total Area (Acres) |
|---|---|---|---|
| Beaverhead | 2,114,577 | 82,705 | 2,197,282 |
| Bitterroot | 1,115,083 | 74,386 | 1,189,469 |
| Custer | 1,113,892 | 86,512 | 1,200,404 |
| Deer Lodge | 1,177,318 | 177,627 | 1,354,945 |
| Flathead | 2,363,392 | 263,920 | 2,627,312 |
| Gallatin | 1,726,707 | 424,056 | 2,150,763 |
| Helena | 972,408 | 186,931 | 1,159,339 |
| Kootenai | 1,779,932[c] | 318,032 | 2,097,964 |
| Lewis and Clark | 1,835,264 | 116,431 | 1,951,695 |
| Lolo | 2,091,043 | 523,881 | 2,614,924 |
| Kaniksu | 446,962[d] | 44,844 | 491,856 |
| Total | 16,736,578[e] | 2,349,375 | 19,085,953 |

a/ All acreages are inside the National Forest Boundary

b/ State and private land inside the National Forest Boundary

c/ Includes 46,395 acres in Idaho which drain into Montana

d/ Lands now administered by the Kootenai National Forest

e/ Does not include 157 acres in Missoula at three facilities

TABLE 24

PRODUCTIVE NON-RESERVED FOREST LANDS EXCLUSIVE OF DEFERRED FOREST LANDS AS OF 12/'77.

| | Productive Timber Lands (Acres) | | | | |
|---|---|---|---|---|---|
| National Forest | Standard | Special | Marginal | Unregulated | Total |
| Beaverhead | 71,370 | 45,075 | 59,547 | 43,523 | 219,515 |
| Bitterroot[a/] | | | | | |
| Custer | 61,322 | 27,137 | 65,066 | 90,999 | 244,524 |
| Deer Lodge | 167,674 | 216,058 | 145,294 | 36,491 | 565,517 |
| Flathead | 201.738 | 255,110 | 186,845 | 112,509 | 756,202 |
| Gallatin | 38,137 | 54,576 | 190,789 | 18,104 | 301,606 |
| Helena | 70,472 | 54,770 | 97,315 | 7,030 | 229,587 |
| Kootenai | 1,046,396 | 251,143 | 121,233 | 187,468 | 1,606,240 |
| Lewis and Clark | 216,820 | 42,732 | 40,449 | 2,124 | 302,235 |
| Lolo | 549,584 | 315,436 | 130,427 | 72,573 | 1,068,020 |
| Total Nat. Forest | 2,423,513 | 1,262,037 | 1,037,075 | 570,821 | 5,293,446[b/] |

a/ Bitterroot data unavailable.

b/ An additional 2,270,606 acres of non-reserved land are included in lakes and as non-forest and non-productive forest lands. Productive forest land constitutes 70 percent of the non-reserved forest lands.

TABLE 25

TIMBER SALE PROGRAM STATISTICS FOR MONTANA NATIONAL FORESTS
(ALL VOLUME IN MMBF)

| Fiscal Year | AAC or Potential Yield | Total Cut | Total Sold | Volume Under Contract (End FY) |
|---|---|---|---|---|
| 1961 | 662.0 | 450.3 | 549.6 | 1,129.5 |
| 1962 | 696.7 | 520.8 | 748.2 | 1,245.5 |
| 1963 | 761.2 | 641.3 | 679.8 | 1,292.1 |
| 1964 | 761.2 | 649.9 | 723.3 | 1,449.0 |
| 1965 | 761.2 | 659.4 | 668.2 | 1,624.4 |
| 1966 | 746.1 | 714.3 | 654.1 | 1,742.6 |
| 1967 | 766.3 | 683.3 | 664.4 | 1,713.6 |
| 1968 | 802.3 | 680.3 | 730.2 | 1,685.1 |
| 1969 | 830.3 | 725.6 | 725.8 | 1,790.7 |
| 1970 | 895.1 | 704.2 | 1,181.4 | 2,307.6 |
| 1971 | 955.5 | 657.8 | 576.6 | 1,828.6 |
| 1972 | 955.5 | 659.2 | 425.0 | 1,588.6 |
| 1973 | 941.3 | 567.3 | 449.6 | 1,427.1 |
| 1974 | 916.6 | 534.9 | 457.1 | 1,373.5 |
| 1975 | 916.6 | 453.1 | 524.0 | 1,401.6 |
| 1976 | 916.6 | 444.1 | 448.5 | 1,444.8 |
| Total | 13,284.5 | 9,745.8 | 10,205.8 | 25,044.3 |
| Average | 830.3 | 609.1 | 637.9 | 1,565.3 |

1976. Over 80 percent of these sales were valued at $300 or less while less than four percent involved volumes of 2.0 MMBF or greater. An additional 376,070 acres were examined for future timber sales or silviculturally treated by other than timber sales. The total silviculture and logging program in Montana's National Forest in 1976 affected 409,106 acres. Of this 103,544 acres were subjected to varying degrees of site disturbance or alteration, exclusive of roads.

The U. S. Forest Service has developed a sensitivity rating for each watershed in Montana's National Forests. The ratings express susceptibility to erosion as a result of land use activities.

1) High sensitivity recognizes a high (80 percent) probability of accelerating erosion and of polluting the area's waters when following routine, normal management practices. Prevention of erosion in these areas will require extraordinary measures. In some situations, prevention may not be feasible under existing technology and knowledge.

2) Moderate sensitivity is the most commonly occuring sensitivity class. Accelerating erosion due to oversight or carelessness in carrying out routine management practices can occur, but adequate quality control should overcome most problems.

3) Low sensitivity lands present few constraints to management, or there is little probability (20 percent) of accelerating erosion when following routine management practices.

The sensitivity classification is intended to alert land use planners to possible erosion problem areas prior to project initiation. None of the classes are pure at 1:500,000 map scale; i.e., all classes have inclusions of the other two classes. However, as the planning level progresses toward the site specific, class purity will increase. Finalized maps depicting the sensitivity classes should be available by Spring, 1979.

The U. S. Forest Service has also identified water quality problem areas in Montana forests. Maps are being finalized to depict these problem areas which are summarized by activity, severity, and feasibility for correction in Table 26. Table 26 also essentially summarizes management priorities on National Forest lands in Montana; roads, by virtue of impact severity and high feasibility for correction are the major management priority.

Land disposal--Surface and subsurface disposal of waste products is a potential threat to both surface and ground-water quality. Ground-water impacts are discussed in a following section.

Surface water quality impacts occur directly as the result of runoff discharge into receiving streams or indirectly as the result of recharge of polluted ground water to surface waters. The major land disposal water quality problem in the Statewide 208 area is sanitary land filling.

TABLE 26

AN EVALUATION OF POLLUTION IMPACTS ON MONTANA'S NATIONAL FORESTS

| | SEVERITY OF IMPACT | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HIGH | | | | MODERATE | | | | LOW | | | |
| | Feasibility of Correction | | | | Feasibility of Correction | | | | Feasibility of Correction | | | |
| Activity | High | Moderate | Low | Total | High | Moderate | Low | Total | High | Moderate | Low | Total |
| Roads | 7 | 18 | 5 | 30 | 37 | 34 | 6 | 77 | 15 | 15 | 13 | 43 |
| Timber Harvesting & Logging | 2 | 7 | 5 | 14 | 24 | 17 | 7 | 48 | 23 | 13 | 3 | 39 |
| Grazing & Stockwater | 6 | 9 | 4 | 19 | 11 | 27 | 11 | 49 | 20 | 33 | 21 | 74 |
| Municipal & Domestic | 1 | | | 1 | 2 | | | 2 | | 2 | | 2 |
| Recreation & Aesthetics | | | 1 | 1 | 3 | 4 | 2 | 9 | 12 | 5 | 20 | 37 |
| Mining | | 3 | 4 | 7 | 2 | 14 | 8 | 24 | 3 | 4 | 7 | 14 |
| Total | 16 | 37 | 19 | 72 | 79 | 96 | 34 | 209 | 73 | 73 | 64 | 210 |

Again, though most of the problem sites are causing ground-water impacts, a few are or have the potential to affect surface waters. Nine of the 36 sites examined had existing surface water quality problems or had the potential to develop future water quality impacts. Those sites are discussed below.

Cascade (Cascade County)--The Cascade disposal site was opened some fifty years ago prior to implementation of disposal regulations. Although precipitation in the area is low, leachate will inevitably form during wetter seasons. The disposal site is located near the Missouri River which receives the leachate. It is likely the river effectively dilutes the polluted runoff now, but the contribution may become more significant in the future.

Fresno (Hill County)--This site is situated so that potential problems could arise. The surrounding area is predominantly agriculture land and significant amounts of herbicides and pesticides are in use. If these hazardous wastes are disposed of at this site and the area were to experience large amounts of precipitation, the hazardous wastes could enter Havre's water supply. In view of this significant threat, the site needs to be relocated or closed to disposal of agricultural hazardous wastes.

Glasgow (Valley County)--The site is located in a natural drainage leading to the Cherry Creek drainage. Cherry Creek is one of Glasgow's main water supplies. Although low precipation and continuation of good operation practices should keep the amount of leachate to a minimum, the importance of Cherry Creek warrants additional evaluation of the site.

Great Falls (Cascade County)--The site is located 3/8 of a mile south of the Missouri River and is expanding down a natural draw towards the river. The current practice of infrequent covering of refuse allows direct infiltration and produces more contaminated leachate. As landfill operations commence towards the Missouri River, the leachate will become a greater threat unless operation practices are altered.

Lima (Beaverhead County)--The site is located in the Junction Creek floodplain and serves a rural and agricultural population. As in the Fresno site, the potential for disposal of herbicides, pesticides, and other hazardous materials is a serious threat to the quality of Junction Creek.

Livingston (Park County)--Ground-water pollution at the site is an accepted fact. And, although ground water flows to the Yellowstone River, actual impacts on the river have not been documented. However, the possibility of degradation is sufficient to warrant further evaluation of the situation.

Sand Coulee (Cascade)--There is no doubt that the site is contributing polluted leachate to Mining and Sand Coulee Creeks. However, both streams are already severely polluted by acid mine drainage.

Nevertheless, Sand Coulee Creek does enter the Missouri River south of Great Falls and possible upgrading of Sand Coulee Creek's water quality needs to be evaluated.

Sheridan (Madison County)--Ground-water pollution is evident at this site. Although the Ruby River ultimately receives ground water from the site, the leachate is probably sufficiently diluted prior to reaching the recharge point. However, the site is unattended and open continuously and the potential for disposal of hazardous wastes is high.

Ulm (Cascade)--Under ideal conditions this site could act as a dam. Ponded water would leach contaminants from refuse and may even wash out the site. Since all drainage from the site eventually reaches the Missouri River, its pollution potential is noteworthy.

Dewatering--All Streams in Montana are dewatered, i.e., a certain amount of water is removed from every stream for one or more beneficial uses. By strict definition, dewatering itself is not pollution, but in some cases reduced flows do contribute to water quality degradation and so, deserve attention from a nonpoint source management aspect.

Essentially, the major effects of dewatering are reduction of the stream's dilution capacity and a decrease in biotic habitat. In extreme cases, the stream channel may become totally dry. With reduced flows mineral and temperature increases and oxygen depletion may create toxic conditions for biota and reduce quality of the water for other beneficial uses. The problem may be compounded by additional pollutant loads which the stream can no longer adequately assimilate.

The degree to which a stream's quality is degraded by dewatering depends on several factors: pre-existing water level and quality, total amount of water removed, duration of reduced flows, time of year the dewatering occurs, and the social, economical, and environmental value of the stream prior to dewatering. The problem is often a subtle one, particularly on larger streams where significant amounts of water can be removed without apparent noticeable effects.

Although critical dewatering has been most noticeable in the Beaverhead, Bitterroot, West Gallatin, Big Hole, and Jefferson Rivers, many other stream segments are affected annually. The Conservation District's questionnaire and the Fish and Game have helped to more accurately identify the extent of the dewatering problem. Any beneficial use can potentially dewater a stream to the point that its quality is reduced, however, since irrigation accounts for more than 80 percent of the annual water losses in Montana, both surveys have concentrated on that aspect of dewatering.

Some of the most obviously and critically dewatered streams were identified by the Conservation District questionnaire. By definition, the survey identified streams which were dewatered by irrigation withdrawal to the point that: 1) the stream is actually or for all practical purposes, dry; 2) the stream is reduced to a series of separated pools, or 3) significant portions of the streambed, which would otherwise be under water, are exposed. Dewatered segments identified by the Districts totalled 873 miles (Table 27, Figure 2-map pocket).

TABLE 27

MILES OF DEWATERED STREAM SEGMENTS IN THE STATEWIDE 208 STUDY AREA

| Basin | Miles Dewatered |
|---|---|
| Kootenai | 4 |
| Clark Fork | 155 |
| Jefferson | 41 |
| Madison | 0 |
| Upper Yellowstone | 32 |
| Upper Missouri | 55 |
| Marias | 67 |
| Middle Missouri | 135 |
| Musselshell | 224 |
| Milk | 160 |
| Lower Missouri | 0 |
| Lower Yellowstone | 0 |
| Lower Tongue | 0 |
| Beaver | 0 |
| | 873 |

The Fish and Game survey identified 285 stream segments in which the fishery resource value is reduced by agricultural removal of water. These segments total 7,618.5 km. The Fish and Game figures represent the total length of the stream segments in the survey, not the total length affected by a particular problem. For example, 45.7 km. of the Beaverhead River was included in the survey and that segment is affected by dewatering; however, dewatering may not necessarily be occurring along the total length of that segment. Table 28 lists the affected segments.

Ground Water

From a management aspect, the major emphasis in the Statewide 208 area and Montana has been on surface waters. However, ground water shares the same hydrologic cycle with surface water and its occurrence and quality are affected by and in turn, affect quality and quantity of surface water. The two are intimate and management of one cannot be effectively accomplished without consideration of the other. If surface water degradation as well as demands for clean water continue in Montana, importance of ground water will also increase. In an effort to determine the quality of ground water in the Statewide 208 area and quantify research and management needs, the WQB contracted with Westech for a ground-water assessment. The following discussion is extracted from their report by Botz and Gartner (1978).

Ground-water Quality in the Statewide 208 Area--The Montana Water Quality Records System (MTWQRS), described in detail in Westech's report, was used to assess ground-water quality in the Statewide 208 area. The system used computer-plotted maps to show sample sites and ranges of concentrations for seven parameters including; specific conductance, total hardness, sodium absorption ratio, sulfate, nitrate, nitrite, iron, and zinc. In addition, one map indicates if any of the following 9 metals had been analyzed for: aluminum, cadmium, copper, iron, lead, manganese, mercury, molybdeum, selenium.

Distribution, quantity, and quality of ground-water resources varies greatly in the Statewide 208 study area. Quality is generally good to excellent in mountainous areas and poor in eastern and northern portions of Montana with predominantly sedimentary geological formations and less precipitation. Dominant quality problems throughout the state consist of high total dissolved solids, sulfate, and sodium. The following points were summarized from the MTWQRS data:

1. Western Montana ground water generally has specific conductances less than 700 umhos (suitable for most uses) except for scattered points, an area along the Beaverhead River, and near Townsend and Helena. Many central and eastern portions had nearly all conductances above 750 umhos with many above 2,250 µmhos (limited use, even for irrigation).

2. Hardness in most of Montana ranges from 60-180 mg/l with many eastern sites showing excesses of 180 mg/l (rated very hard by USGS). Fifty-nine percent of the plotted points showed values greater than 180 mg/l.

TABLE 28

MONTANA STREAMS WITH REDUCED FISHERY RESOURCE VALUE DUE TO WATER REMOVAL OR FLUCTUATION FOR AGRICULTURE

| Stream Segment | Tributary To | Segment Length (Km) |
|---|---|---|
| Alder Gulch | Ruby River | 17.9 |
| Beaverhead River | Jefferson River | 101.0 |
| Blacktail Deer Creek | Beaverhead River | 43.5 |
| Grasshopper Creek | Beaverhead River | 64.3 |
| Indian Creek | Ruby River | 10.6 |
| Little Sheep Creek | Red Rock River | 18.6 |
| Long Creek | Red Rock River | 14.0 |
| Medicine Lodge Creek | Horse Prairie Creek | 28.2 |
| Mill Creek | Ruby River | 10.1 |
| Nicholia Creek | Big Sheep Creek | 23.8 |
| O'Dell Creek | Red Rock River | 19.5 |
| Rattlesnake Creek | Beaverhead River | 29.9 |
| Red Rock River | Clark Canyon Reservoir | 30.4 |
| Red Rock River | Beaverhead River | 34.0 |
| Ruby River | Beaverhead River | 98.9 |
| Sage Creek | Red Rock River | 38.6 |
| Big Sheep Creek | Red Rock River | 4.8 |
| Spring Creek | Beaverhead River | 10.6 |
| Sweetwater Creek | Ruby River | 5.5 |
| Wisconsin Creek | Ruby River | 5.8 |
| Poindexter Slough | Beaverhead River | 8.0 |
| Big Hole River | Jefferson River | 79.7 |

| Stream Segment | Tributary To | Segment Length (Km) |
|---|---|---|
| Big Hole River | Jefferson River | 50.4 |
| Big Hole River | Jefferson River | 84.5 |
| Birch Creek | Big Hole River | 16.4 |
| Camp Creek | Big Hole River | 21.2 |
| Trapper Creek | Big Hole River | 10.1 |
| Willow Creek | Big Hole River | 17.9 |
| Bass Creek | Bitterroot River | 11.3 |
| Bitterroot River | Clark Fork River | 36.9 |
| Bitterroot River | Clark Fork River | 27.4 |
| Bitterroot River | Clark Fork River | 66.6 |
| Burnt Fork Creek | Bitterroot River | 25.6 |
| East Fork Bitterroot River | Bitterroot River | 11.4 |
| Lolo Creek | Bitterroot River | 45.3 |
| Miller Creek | Bitterroot River | 8.7 |
| Miller Creek | Bitterroot River | 12.2 |
| Skalkaho Creek | Bitterroot River | 12.9 |
| West Fork Bitterroot River | Bitterroot River | 31.5 |
| Blackfoot River | Clark Fork River | 69.2 |
| Blackfoot River | Clark Fork River | 47.5 |
| Clearwater River | Blackfoot River | 27.0 |
| Cottonwood Creek | Blackfoot River | 19.3 |
| Nevada Creek | Blackfoot River | 35.4 |
| Nevada Creek | Blackfoot River | 24.6 |
| Placid Creek | Owl Creek | 13.8 |
| Poorman Creek | Blackfoot River | 9.3 |
| Deep Creek | Clark Fork River | 1.6 |

| Stream Segment | Tributary To | Segment Length (Km) |
|---|---|---|
| Dry Creek | Clark Fork River | 4.8 |
| Little Thompson River | Thompson River | 23.8 |
| Nine Mile Creek | Clark Fork River | 39.8 |
| Pilgrim Creek | Clarks Fork River | 13.4 |
| Dempsey Creek | Clark Fork River | 19.3 |
| Douglas Creek | Flint Creek | 1.5 |
| East Fork Rock Creek | Rock Creek | 12.9 |
| Flint Creek | Clark Fork River | 42.0 |
| Flint Creek | Clark Fork River | 17.5 |
| Lost Creek | Clark Fork River | 24.1 |
| Lower Willow Creek | Flint Creek | 11.5 |
| Little Blackfoot River | Clark Fork River | 37.2 |
| Middle Fork Rock Creek | Rock Creek | 23.7 |
| Mill Creek | Silver Bow Creek | 6.8 |
| Racetrack Creek | Clark Fork River | 1.5 |
| Ranch Creek | Rock Creek | 15.4 |
| Schwartz Creek | Clark Fork River | 5.6 |
| Warm Springs Creek | Clark Fork River | 45.7 |
| Little Bitterroot River | Flathead River | 11.3 |
| Little Bitterroot River | Flathead River | 24.1 |
| Stillwater River | Flathead River | 32.5 |
| Stillwater River | Flathead River | 21.9 |
| Whitefish River | Stillwater River | 8.4 |
| Whitefish River | Stillwater River | 15.3 |
| Whitefish River | Stillwater River | 15.4 |
| Baker Creek | Gallatin River | 3.1 |

| Stream Segment | Tributary To | Segment Length (Km) |
|---|---|---|
| Baker Creek | Gallatin River | 8.7 |
| Camp Creek | Gallatin River | 14.5 |
| Hyalite Creek | Gallatin River | 5.6 |
| Hyalite Creek | Gallatin River | 8.2 |
| Smith Creek | East Gallatin River | 6.6 |
| Sourdough Creek (Bozeman C) | East Gallatin River | 10.6 |
| Gallatin River | Missouri River | 16.7 |
| Gallatin River | Missouri River | 17.7 |
| Big Pipestone Creek | Jefferson River | 15.1 |
| Big Pipestone Creek | Jefferson River | 10.1 |
| Boulder River | Jefferson River | 22.7 |
| Boulder River | Jefferson River | 48.9 |
| Cherry Creek | Jefferson River | 3.9 |
| Dry Boulder Creek | Jefferson River | 8.0 |
| Dry Creek | Boulder River | 9.7 |
| Fish Creek | Jefferson River | 14.5 |
| Jefferson River | Missouri River | 73.1 |
| Jefferson River | Missouri River | 18.7 |
| Jefferson River | Missouri River | 30.7 |
| North Willow Creek | Willow Creek | 17.4 |
| South Boulder River | Jefferson River | 4.8 |
| South Boulder River | Jefferson River | 10.8 |
| South Willow Creek | Willow Creek | 22.4 |
| Willow Creek | Jefferson River | 17.7 |
| Willow Creek | Jefferson River | 1.1 |
| East Fisher River | Fisher River | 20.4 |

| Stream Segment | Tributary To | Segment Length (Km) |
|---|---|---|
| Elk Creek | Fisher River | 15.0 |
| Fisher River | Kootenai River | 51.8 |
| Fortine Creek | Tobacco River | 37.7 |
| Grave Creek | Tobacco River | 27.8 |
| Indian Creek | Tobacco River | 6.4 |
| Laughing Water Creek | Murphy Lake | 3.5 |
| Libby Creek | Kootenai River | 20.8 |
| McGinnis Creek | Elk Creek | 15.1 |
| Mud Creek | Therriault Creek | 6.1 |
| Pinkham Creek | Kootenai River | 9.7 |
| Pinkham Creek | Kootenai River | 24.1 |
| Pleasant Valley Fisher River | Fisher River | 19.3 |
| St. Clair Creek | Tobacco River | 1.8 |
| St. Clair Creek | Tobacco River | 11.6 |
| Tobacco River | Kootenai River | 34.1 |
| Young Creek | Kootenai River | 10.0 |
| Birch Creek | Two Medicine River | 60.2 |
| Cut Bank Creek | Marias River | 7.1 |
| Deep Creek | Teton River | 22.5 |
| Dupuyer Creek | Birch Creek | 13.5 |
| Dupuyer Creek | Birch Creek | 38.3 |
| Marias River | Missouri River | 12.9 |
| McDonald Creek | Teton River | 16.1 |
| North Fork Deep Creek | Deep Creek | 8.8 |
| North Fork Dupuyer Creek | Dupuyer Creek | 5.0 |
| North Fork Willow Creek | Willow Creek | 10.9 |

| Stream Segment | Tributary To | Segment Length (Km) |
|---|---|---|
| South Fork Deep Creek | Deep Creek | 6.0 |
| South Fork Dupuyer Creek | Dupuyer Creek | 6.4 |
| South Fork Willow Creek | Willow Creek | 10.3 |
| Teton River | Marias River | 265.5 |
| Teton River | Marias River | 16.1 |
| Teton River | Marias River | 48.3 |
| Willow Creek | Deep Creek | 20.9 |
| Beaver Creek | Milk River | 24.1 |
| Beaver Creek | Milk River | 12.9 |
| Little Box Elder Creek | Milk River | 39.1 |
| Milk River | Missouri River | 165.6 |
| Milk River | Missouri River | 165.6 |
| Milk River | Missouri River | 82.8 |
| Milk River | Missouri River | 215.7 |
| Milk River | Missouri River | 19.3 |
| Muddy Creek | Milk River | 7.9 |
| Peoples Creek | Milk River | 28.3 |
| Arrow Creek | Missouri River | 15.3 |
| Cottonwood Creek | Arrow Creek | 12.1 |
| Cow Creek | Missouri River | 4.8 |
| Eagle Creek | Missouri River | 12.4 |
| Judith River | Missouri River | 35.2 |
| North Fork Cow Creek | Cow Creek | 8.0 |
| South Fork Cow Creek | Cow Creek | 8.2 |
| Wolf Creek | Judith River | 8.0 |
| Avalanche Creek | Canyon Ferry Reservoir | 5.1 |

| Stream Segment | Tributary To | Segment Length (Km) |
|---|---|---|
| Beaver Creek | Smith River | 10.6 |
| Beaver Creek | Missouri River | 22.5 |
| Butte Creek | Sheep Creek | 15.1 |
| Camas Creek | Smith River | 23.3 |
| Crow Creek | Missouri River | 13.2 |
| Crow Creek | Missouri River | 9.0 |
| Dearborn River | Missouri River | 75.6 |
| Deep Creek | Missouri River | 4.0 |
| Deep Creek | Missouri River | 18.8 |
| Dry Creek | Missouri River | 12.9 |
| Eagle Creek | Smith River | 13.4 |
| Hound Creek | Smith River | 45.7 |
| Little Belt Creek | Belt Creek | 24.9 |
| Little Prickly Pear Creek | Missouri River | 43.0 |
| Little Prickly Pear Creek | Missouri River | 13.8 |
| Missouri River | Mississippi River | 211.9 |
| Newlan Creek | Smith River | 29.6 |
| North Fork Smith River | Smith River | 14.5 |
| North Fork Smith River | Smith River | 14.3 |
| Otter Creek | Belt Creek | 21.3 |
| Seven Mile Creek | Ten Mile Creek | 8.7 |
| Sheep Creek | Smith River | 43.6 |
| Silver Creek | Missouri River | 3.4 |
| Smith River | Missouri River | 21.2 |
| Smith River | Missouri River | 29.6 |
| Smith River | Missouri River | 41.0 |

| Stream Segment | Tributary To | Segment Length (Km) |
|---|---|---|
| South Fork Dearborn River | Dearborn River | 16.4 |
| Spring Creek | Smith River | 16.7 |
| Ten Mile Creek | Prickly Pear Creek | 13.7 |
| Thomas Creek | Smith River | 4.0 |
| Cottonwood Creek | South Fork Musselshell River | 10.4 |
| Flagstaff Creek | North Fork Musselshell River | 7.2 |
| Musselshell River | Fort Peck Reservoir | 119.5 |
| North Fork Musselshell River | Musselshell River | 20.9 |
| North Fork Musselshell River | Musselshell River | 6.0 |
| South Fork Musselshell River | Musselshell River | 11.5 |
| South Fork Musselshell River | Musselshell River | 9.4 |
| Big Muddy Creek | Sun River | 12.9 |
| Duck Creek | Sun River | 9.7 |
| Elk Creek | Sun River | 36.8 |
| Ford Creek | Smith Creek | 10.0 |
| Mill Coulee | Sun River | 9.7 |
| North Fork Willow Creek | Willow Creek | 13.4 |
| Smith Creek | Elk Creek | 22.5 |
| Sun River | Missouri River | 29.5 |
| Sun River | Missouri River | 74.3 |
| Sun River | Missouri River | 47.9 |
| Sun River | Missouri River | 4.8 |
| Willow Creek | Sun River | 21.2 |
| Glendive Creek | Yellowstone River | 16.1 |
| Little Powder River | Power River | 106.9 |
| Powder River | Yellowstone River | 350.0 |

| Stream Segment | Tributary To | Segment Length (Km) |
|---|---|---|
| Tongue River | Yellowstone River | 140.5 |
| Tongue River | Yellowstone River | 163.8 |
| Tongue River | Yellowstone River | 22.2 |
| Yellowstone River | Missouri River | 88.0 |
| Yellowstone River | Missouri River | 126.2 |
| Bad Canyon Creek | Stillwater River | 9.3 |
| Bear Creek | Clarks Fork River | 30.4 |
| Big Creek | Yellowstone River | 3.9 |
| Big Timber Creek | Yellowstone River | 17.7 |
| Big Timber Creek | Yellowstone River | 8.9 |
| Bluewater Creek | Clarks Fork River | 14.5 |
| Boulder River | Yellowstone River | 49.2 |
| Bridger Creek | Yellowstone River | 7.2 |
| Bridger Creek | Yellowstone River | 10.8 |
| Butcher Creek and Forks | Rosebud Creek | 45.1 |
| Cayuse Creek | Sweetgrass Creek | 20.1 |
| Cedar Creek | Yellowstone River | 5.6 |
| Clarks Fork Yellowstone River | Yellowstone River | 65.3 |
| Clarks Fork Yellowstone River | Yellowstone River | 46.2 |
| Clear Creek | Rock Creek | 14.2 |
| Cottonwood Creek | Shields River | 4.8 |
| Deep Creek | Yellowstone River | 1.6 |
| Deep Creek | Yellowstone River | 3.5 |
| East Boulder River | Boulder River | 12.8 |
| East Boulder River | Boulder River | 9.3 |
| East Rosebud Creek | Rosebud Creek | 38.6 |

| Stream Segment | Tributary To | Segment Length (Km) |
|---|---|---|
| Eight Mile Creek | Yellowstone River | 6.4 |
| Elbow Creek | Yellowstone River | 20.9 |
| Emigrant Creek | Yellowstone River | 5.6 |
| Hogan Creek | West River Lodge Creek | 4.8 |
| Little Rocky Creek | Stillwater River | 7.1 |
| Little Trail Creek | Yellowstone River | 8.0 |
| Lodgepole Creek | Castle Creek | 2.4 |
| Lower Deer Creek | Yellowstone River | 23.7 |
| Meyers Creek | Lodgepole Creek | 7.2 |
| Midnight Creek | Stillwater River | 9.7 |
| Mill Creek | Yellowstone River | 6.4 |
| Pryor Creek | Yellowstone Eiver | 12.0 |
| Red Lodge Creek | Rock Creek | 15.8 |
| Robinson Draw | Clarks Fork River | 3.7 |
| Rock Creek | Clarks Fork River | 27.8 |
| Rock Creek | Clarks Fork River | 13.7 |
| Rock Creek | Clarks Fork River | 21.1 |
| Rock Creek | Yellowstone River | 11.7 |
| Rock Creek | Shields River | 7.2 |
| Rock Creek | Shields River | 11.6 |
| Rosebud Creek | Stillwater River | 6.0 |
| Sage Creek | Big Horn River | 10.9 |
| Sage Creek | Big Horn River | 11.3 |
| Shields River | Yellowstone River | 25.4 |
| Shields River | Yellowstone River | 21.6 |
| Shields River | Yellowstone River | 45.9 |

| Stream Segment | Tributary To | Segment Length (Km) |
|---|---|---|
| Six Mile Creek | Yellowstone River | 4.8 |
| Stillwater River | Yellowstone River | 6.4 |
| Suce Creek | Yellowstone River | 2.4 |
| Sweetgrass Creek | Yellowstone River | 53.1 |
| Tom Miner Creek | Yellowstone River | 10.9 |
| Tom Miner Creek | Yellowstone River | 6.4 |
| Trail Creek | Yellowstone River | 17.7 |
| Trail Creek | Yellowstone River | 34.6 |
| Upper Deer Creek | Yellowstone River | 22.5 |
| West Red Lodge Creek | Red Lodge Creek | 2.4 |
| Willow Creek | Shields River | 12.2 |
| Willow Creek | Red Lodge Creek | 23.7 |

3. Sodium absorption ratios (SAR) of less than four are suitable for irrigation use. Sixty-one percent of the plotted points had SAR's of less than four; Toole, Liberty, and Cascade counties had values from four to greater than nine. Eastern points were variable ranging from four to nine and above; many locations in McCone, Dawson, and Richland counties exceeded nine.

4. Sulfate is particularly abundant in northern and eastern ground waters. Concentrations in excess of 500 mg/l are unsuitable for most uses. Twenty-nine percent of the plotted points exceeded 500 mg/l. Many eastern and northweastern points exceeded 500 mg/l.

5. Nitrogen in excess of 10 mg/l is unsuitable as a public water supply. Fifty-five percent of the plotted points showed values between .35 - 10.0 mg/l and seven percent of the points scattered throughout the areas exceeded 10 mg/l.

6. In excess of 5 mg/l, iron inhibits many uses. Nearly all points in the Statewide 208 area were less than 0.3 mg/l with a few scattered values of 0.3 - 5 mg/l. Most points in excess of 5 mg/l were either at the Cooke City or Hughesville acid mine drainages.

7. Public water supplies are recommended to contain less than 5 mg/l zinc. Seventeen percent of the plotted points exceeded 5 mg/l. Many of these samples were from acid mine drainages at Cooke City and Hughesville. Though many of the sites have values greater than .01 mg/l, there are insufficient zinc data to determine area trends.

Ground-water Use in Statewide 208 Area--In 1970 only about two percent of the water used in Montana was ground water. Though this is a relatively small percentage, ground water is a vital resource which will be further exploited as surface supplies become limited in quantity and quality.

Major ground-water uses in the study area are irrigation, municipal, industrial, rural, domestic, and livestock. Rural domestic requirements are satisfied almost totally by ground water and amount to 19.6 million gallons per day (mgd). Municipal systems supply 159,000 people 41.9 mgd (31 percent of their supply) of ground water. Industry requires 152.7 mgd of which 3.9 mgd are ground water.

Total water used for irrigation amounts to 12.4 million acre feet (22,165 mgd) over a six-month period. Although only one percent is ground water (222 mgd), this amount is about equal to the entire amount supplied for all other ground-water uses in Montana.

Based on well data, there has been a relatively constant rate of ground-water development for rural domestic and livestock uses. As more rangeland is improved and developed and people move to areas not served by municipal systems, this trend will continue. Similarly, increasing irrigation development, suburban development, and mining can be expected to place heavier demands on Montana's ground-water supplies.

Ground-water Quality Problems in Statewide 208 Area--The difficulty and expense involved in ground-water monitoring have resulted in relatively few documented problems in the Statewide 208 area. Thirty specific problems are show in Table 29; these and general land use-related impacts are discussed below.

oil and gas--Several phases of oil and gas production have the potential to adversely affect ground-water supplies. Though seismic exploration has not been identified as a problem to date, many thousands of such holes are drilled annually, and may, in isolated cases, cause ground-water quality problems. During the processes of getting oil to the surface, separating it from co-produced brines, and storing and transporting the product, ground-water problems can develop due to loss of brine and/or oil to aquifers.

There are an estimated 3,400 producing oil wells in Montana and about 1,000 brine disposals or evaporation pits in use. Given this magnitude of activity, a relatively small number of complaints have been recorded. However, many oil operations are in remote areas, away from used wells where problems are not likely to be reported. The overall impact in the Statewide 208 area is simply poorly known.

Though petroleum refining can cause ground-water problems due to spills and waste disposal, none have been reported in the Statewide 208 area. The lack of documentation may simply be due to the lack of investigation in the area. Potential contamination of ground water by transported petroleum products is great by virtue of the vast existing supply. During 1976, 29,736,442 barrels of crude oil were transported by state pipelines. Total pipeline mileage exceeds 3,000 miles. In addition, products are moved by rail and truck. Again, there have been few reported problems and no intensive investigations in the study area.

There are seven known ground-water problems resulting from petroleum product storage in the Statewide 208 area. In an area with about 3,000-4,000 steel buried storage tanks and 20-25 miles of underground pipe, seven problems seem to be of relatively minor significance.

coal--Vast reserves of subbituminous coal are found along the Rocky Mountain front near the Canadian border and between Great Falls and Lewistown. Total coal reserve base of the state is estimated to be 108 billion tons or 25 percent of the United States' known reserves.

Coal fields in the Statewide 208 study area with high to moderate potentials for development include the Bull Mountains (Musselshell County), North Central field (Liberty, Hill, Blaine, Choteau counties), Wibaux field (Wibaux County), Little Beaver field (Wibaux County), Four Buttes field (Wibaux County), fields in Dawson and Richland counties, Redwater River area (McCone and Dawson counties), and Weldon-Timber Creek field (McCone County). If coal production expands in the Statewide 208 area, it will probably occur at the Knife River Coal Company lignite mine near Savage in Richland County, at the Dryer Brothers' Circle West Ranch lignite mine in McCone County, or in the Wibaux area.

TABLE 29

SUMMARY OF GROUND-WATER PROBLEMS IN THE STATEWIDE 208 AREA

Petroleum Related

| Problem | Location | Date | Impact | Comment |
|---|---|---|---|---|
| 1. Brine leakage from injection wells | Near Cut Bank | 1976 | Saline soils and ground-water | Possibly caused by brine injection in the Cut Bank oil fields |
| 2. Brine seepage from unlined pits | Northeastern Montana, Goose Lake field | 1975 | Trees killed by brine seepage, abandoned wells were flowing water, and soil damage by salt water | Seepage from brine pits. Most problems corrected after initial field report completed |
| 3. Brine seepage from disposal pit | 36N58E33 Goose Lake field | 1975 | Damage to domestic water well; high concentrations of sodium chloride | Well may have been damaged by leakage from the disposal pit. Oil company directed to either discontinue use of the disposal pit and backfill it, or to line the pit |
| 4. Alleged well pollution near oil fields | Cut Bank - Sweetgrass area | | Unknown | Investigated by the WQB. Samples from these wells did not confirm pollution from petroleum activities; complaints have continued |
| 5. Brine seepage from unlined emergency pits | Dwyer oil field 32N58E | 1975 | Unknown; concern that rapid brine seepage may affect the Medicine Lake refuge | No specific problems were described and present status of the reported unlined pond is unknown |

| | Problem | Location | Date | Impact | Comment |
|---|---|---|---|---|---|
| 6. | Oil Spill | Raymond field 36N54E | 1975 | None | Field investigation showed no problems with oil and brine discharge pits. No detailed information |
| 7. | Brine seepage from unlined pit | Outlook field 36N52E | 1975 | Land south of pit was barren for at least 100 feet by 50 feet. Deep, eroded trenches extending from pit | Pit was taken out of service after the site visit |
| 8. | Crude oil seepage and brine spills | Murphy field, North of Poplar | 1975 | Brine had spilled from ponds. One water injection well was found flowing water with a conductivity of 90,000 μmhos. Shallow groundwater appeared to be degraded by brine leakage | Problems seemed to be localized. Main damage appeared to be to small tracts of land and some impacts on groundwater at the Murphy oil field |
| 9. | Gasoline pollution | Deer Lodge | April 1972 | Strong gasoline odors in municipal water supply. Water surface in the well was covered with gasoline | Well was rehabilitated and has been operating successfully |
| 10. | Diesel fuel spill (several thousand gallons) | Deer Lodge | 1970-1971 | Migrating toward the Clark Fork River and threatening a municipal supply well | No detailed investigation of problem |
| 11. | Gasoline spill (22,000 gallons) | Missoula | Sept. 1973 | Petroleum odors in water wells. Strong odors at times, nonexistent during most of the year | Petroleum company provided carbon filtration units for some wells to remove organics. Gasoline has moved about 4000 feet in two years |
| 12. | Gasoline spill (126,000 gallons) | Missoula | Sept. 1972 | Well contamination 3000 feet from spill | Pipeline leakage for 30-60 days. New wells drilled, carbon filters installed, odors became less noticeable |

| | Problem | Location | Date | Impact | Comment |
|---|---|---|---|---|---|
| 13. | Gasoline leakage (10,000 gallons) | Conrad retail gasoline station | March 1975 | Gasoline and oil in basement. Heavy fumes | Examined by WQB in June, 1975. Corrective program outlined. |
| 14. | Diesel fuel spill (18,000 gallons) | Glendive, 2000 feet from Yellowstone River, 3000 feet from Glendive Creek | 1975 | No known groundwater contamination | City engineer indicated he would examine the area. No known detailed investigation |
| 15. | Diesel fuel pollution | Livingston groundwater drain | 1977 | Impact to surface waters at the drain outlet | Source unknown. May be related to fuel oil storage at a nearby railroad. Under active consideration by the WQB |

## Agriculture Related

| | Problem | Location | Date | Impact | Comment |
|---|---|---|---|---|---|
| 16A. | Saline seep (164,000 acres) | Northcentral, central, and northeastern Montana | Continuous | Impairs or eliminates productive plant growth. Contaminates wells with saline waters. Pollutes streams. | Problem is understood fairly well. Needed changes in farming practices have been slow. |
| 16B. | Irrigation salinity (58,000 acres) | Phillips, Teton, Blaine, Deer Lodge, Beaverhead, Madison, Jefferson and Meagher counties | Continuous | Impairs or eliminates productive plant growth. Contaminates wells with saline waters. Pollutes streams | Problem is poorly documented. Has not been intensively studied. |
| 17. | Pesticide disposal | Great Falls | | Contaminated soils. Health hazard to pets and children | Pesticides flushed into an open seepage ditch |

## Wood Products

| | Problem | Location | Date | Impact | Comment |
|---|---|---|---|---|---|
| 18. | Infiltration of log spraying water | Bonner, wood products plant | 1975 | Odor and taste problems in domestic wells located near ponded effluent | Corrective steps taken to improve the operation. Company worked with community on improvement of water supply. |
| 19. | Paper mill wastewater seepage | Frenchtown | 1974 | Complaints of phenol odors in domestic wells | No substantial cases of groundwater degradation peripheral to the Hoerner-Waldorf property |
| | | | | **Mining and Mineral Processing** | |
| 20. | Acid mine drainage | Numerous (see Schmidt and Botz, 1978) | Continuous | Seepage to streams, severely impacts aquatic life | It is seldom cost-effective to abate/correct these problems. Attempts are being made to abate acid drainage at Hughesville and Cooke City |
| 21. | Opportunity tailings ponds seepage (4000 acres) | Opportunity | Continuous | Possible saturated solutions of calcium sulfate and small quantities of metals beneath and peripheral to ponds | No detailed investigations have been done. Movement of water is eastward or northeasterly to the Clark Fork River |
| 22. | Warm Springs tailings ponds seepage (1600 acres) | Warm Springs | Continuous | Seepage of metals downstream from middle pond to a lower pond. Overall impact unknown | No detailed investigation of groundwater conditions in the area. No major groundwater pollution problem is thought to be present |
| | | | | **Solid Waste** | |
| 23. | Solid waste disposal site | Livingston, adjacent to | 1977 | Groundwater was degraded substantially by both | Leachates downgradient from disposal site were typical of |

| | Problem | Location | Date | Impact | Comment |
|---|---|---|---|---|---|
| 23. | (Continued) | Yellowstone River | | organic and inorganic constituents. Seeps to Yellowstone River | other landfills in the U.S. |
| 24. | Solid waste disposal sites | Anaconda, Butte, Cascade, Choteau, Darby | 1977 | Creation of leachates due to precipitation, high seasonal groundwater, or spring runoff | These communities have intermittent seepage of leachates. Have a low to moderate potential for pollution |

Sanitary Waste

| | Problem | Location | Date | Impact | Comment |
|---|---|---|---|---|---|
| 26. | Domestic sewage, septic tank failure | South Libby flats (2,200 residents) | Continuing | Potential contamination of domestic wells | DHES recommended further monitoring |
| 27. | Well flooding | Sewell's Addition #4, Helena Valley (41 acres) | 1971 Continuing | Potential contamination of domestic wells | Further subdividing of this project has been delayed |
| 28. | Sewage treatment systems failure | Opportunity (600 families) | Continuing | Threat of human health-fecal coliform contamination of wells | No definite plans implemented for installation of water or sewer systems |
| 29. | Cesspool failures | H & R Addition, Hamilton (100 lots) | Mid-1960s Continuing | Sewage entering high groundwater proximity of Skalkaho Creek | Further study recommended by DHES |
| 30. | Flood irrigation affecting sewage systems | Five Acre Tracts Livington (407 units) | 1930s - Continuing | Contaminated domestic wells | Contaminated irrigation return flows enter Yellowstone River |

To date, coal mining in the Statewide 208 area has been free from substantial water quality problems. The Knife River Coal Company's mine, producing 300,000 tons per year, is located five miles upstream from the Yellowstone River on an ephemeral drainage. The company has applied for a Montana Pollutant Discharge Elimination System (MPDES) permit for discharge of mine and runoff water through settling ponds. No major water quality problems have been noted at the operation. Two Bull Mountain mines in Musselshell County have operated without water quality problems, mainly because of their small size and location in a dry area.

Even though no major water quality problems are known to exist in the Statewide 208 area due to coal mining, problems that have been noted elsewhere could develop in the project area if mining is expanded. These potential problems include dewatered and polluted aquifers and disruption of the hydrologic balance in alluvial valley floors.

Should eastern lignite deposits be substantially developed, it is likely this low quality coal will remain in-state and be converted to electricity, gas, fertilizer, or some other higher grade product. Such conversion complexes can degrade ground-water systems by contaminating them with cooling tower blowdown, brine, ash, and wastewater.

Presently, only one coal conversion complex exists in the Statewide 208 area; the Montana-Dakota Utilities steam electric generating plant at Sidney has experienced no known water quality problems. With the large coal reserves and Fort Peck Reservoir available in McCone County, development of coal conversion facilities in the area is possible. However, since no construction plans have been finalized, it is difficult to predict the type and extent of possible water quality problems.

<u>uranium</u>--Jefferson County deposits of uranium were mined extensively after their discovery in the late 1950's; however, mining has since ceased. Other deposits in the Statewide 208 area include those in Mineral, Ravalli, Beaverhead, Lewis and Clark, Broadwater, and Jefferson counties, in eastern lignite deposits, and in southwestern phosphorite deposits. Although prospecting and leasing are active, no commercial deposits have been announced and it appears that development of underground or open-pit uranium mines in the next 10-15 years in the Statewide 208 area is unlikely. Nevertheless, the USGS (1968) states: "If the need were great enough, very large quantities of uranium could be recovered from the uraniferous lignite deposits of eastern Montana and from the phosphorite deposits of western Montana. Montana, therefore, is an important potential source for the future production of uranium."

Thus, potential future impacts must be considered. Such impacts could include: aquifer, dewatering, and liquid and solid waste disposal and storage.

<u>potash solution mining</u>--Mineable potash deposits are found in the northeastern counties of Sheridan, Daniels, and Roosevelt. However, the deposits are found in deep sedimentary rocks at the 7,000-9,000 foot

depth and are available only by solution mining techniques. Currently, no solution mining of potash occurs in the United States. However, the drive to nationalize Saskatchewan's potash industry, which presently supplies one-fourth of the world's potash needs, may lead to development of Montana's supplies. Solution mining involves well drilling, pumping a dissolving solution down a well, and removing brine solutions. The brine solutions are then evaporated and potash removed. Dangers to ground water include interaquifer exchange and direct aquifer contamination.

minerals--As stated previously, there is substantial mining and processing of a variety of minerals in the Statewide 208 area. Various stages of the operations have the potential to degrade ground-water quality.

Mineral removal frequently results in acid mine drainages, of which there are many in the Statewide 208 area. Ground-water in these areas becomes polluted with acid water and metals. Processing activities, including crushing, washing, sorting, concentrating, leaching, and refining, all occur in the Statewide 208 area and each has liquid and/or solid wastes requiring disposal; however, at this time, no known ground-water problems have been documented.

There are seven concentrating facilities in the Statewide 208 area where ore is chemically and physically processed to concentrate a specific mineral. The Red Pine flotation mill separates gold; the Anaconda Company concentrator in Butte produces copper; the Babbit Mine near Thompson Falls produces tungsten; there is a gold stamp mill west of Townsend; and there is a flotation-cyanide mill near Virginia City. No known ground-water problems exist at these sites; however, it is possible disposal of concentrator waste materials is degrading subsurface systems.

There are a number of cyanide and acid leaching operations in the project area designed to produce silver, gold, and copper. During the operation, the opportunity exists for leaching of contaminants into ground-water; however, at this time, no such problems have been documented.

Similarly, the several refining facilities throughout the area produce potentially harmful by-products but each of the investigations has resulted in no problem documentation.

On the other hand, quality problems resulting from tailings and waste disposal have been documented. Water infiltrating these dumps creates a polluted water body that enters the ground-water system.

agriculture--Five facets of the agricultural industry have the potential to adversely affect ground water: dryland farming, irrigation, fertilizer use, pesticide use, and feedlot operation.

1) dryland farming--About 11 million acres in the Statewide 208 area are used for dryland farming. Much of this land is farmed in a crop-fallow rotation system which is conducive to saline seep development and increased recharge to ground water.

Saline seep waters have very high concentrations of dissolved solids, sulfate, nitrate, sodium, magnesium, and trace metals. The waters are unsuitable for nearly all uses and eliminate or inhibit vegetative growth. The basic hydrologic flow system consists of precipitation infiltration into salt-laden soil, dissolution of salt, percolation of salty water and lateral movement in the ground-water system, and reappearance of salt-laden ground water on ground surface. Saline seep detrimentally affects agriculture land, but also is a potential threat to water supply systems, ponds, reservoirs, springs and streams. Saline seeps are characteristic of shallow aquifer systems which are a major water source for rural and municipal use and are hydrologically connected to springs, ponds, and streams.

Total acreage affected by saline seep in Montana is estimated by various sources to be from 140,000 to 200,000 acres. The Conservation District survey estimated 164,400 acres in just the Statewide 208 area were being affected by saline seep. However, all reports agree that affected acreage is increasing annually. This increase is attributable not only to continuation of crop-fallow system, but to the fact that annually, thousands of acres of rangeland are being converted to dryland farming.

The wide-spread occurrence of saline seep and the tendency towards annual increase of the problem make it one of the most significant threats to Montana's ground-water supplies.

Although there has been considerable research on saline seeps, there have been few on-the-ground attempts at correction or prevention. Most solutions require less profitable crops or a change in standard farming practices and consequently, public acceptance of the solutions has been slow. Even with comprehensive acceptance and implementation of successful management practices, recovery of already affected aquifers will be slow and saline seep will continue to adversely affect Montana's ground water for many years.

2) irrigation--Crop irrigation, either by sprinklers or flooding, contributes fertilizers, pesticides, and minerals to ground water. Unfortunately, few data are available to quantify these impacts.

It has been estimated that in an efficient irrigation system, 80 percent of the water is lost by evapo-transpiration. The remaining 20 percent that enters the ground-water system increased the concentration of the original salt load by as much as 500 percent. However, most irrigators, concerned about maintaining their water right, use excessive amounts of water. Typically, five acre-feet/acre (average crop need is two-three acre-feet/acre) are diverted annually with a return of two acre feet/acre to streams.

Extensive investigations have been conducted in many states in an attempt to determine specific impacts of irrigation on ground water. The impacts are highly variable and dependent on the site, operator, amount and quality of applied water, ground-water quality, and fertilizer and pesticide application techniques. It is highly probable with the large acreages of irrigated land (1,828,617 acres) in the project area, the variety of operating techniques used, and the extreme variation in site-

specific characteristics, that there are numerous cases of ground-water degradation. However, the impacts are virtually unknown and a necessary first step in solution of the problem is development of an understanding of the relationship of irrigation and ground-water quality in Montana.

3) fertilizers and pesticides--Little or no research has been conducted in the Statewide 208 area to determine the degree of impact of fertilizers and pesticides on ground-water systems. However, studies in other states have documented adverse impacts and the extensive use of fertilizers and pesticides in Montana warrants ranking their use as a potential threat to ground water.

4) feedlots--There are approximately 175 permitted feedlots in Montana. The Conservation Districts estimated there are 183 feeding facilities in Statewide 208 area which contribute runoff to streams; however, there have been few documented impacts of feedlots on ground water. A study by Montana Testing Labs did show that nitrate concentrations do increase below feedlots. Numerous studies in other areas also indicate that nitrate does move into ground water; the degree of movement is determined by soil type, amount of precipitation, number of animals, and length of confinement.

It is likely that some feedlots in the study area are contaminating ground water, but the extent of the problem remains to be quantified. In many cases, changes in management would probably serve to lessen or eliminate the problem.

forest products--As indicated in the previous section on silviculture, timber harvest is a major industry in Montana. Several steps in the process have the potential to degrade ground water. Excess water from log spraying can infiltrate to subsurface systems carrying organic chemicals. Surface and subsurface disposal of wood wastes, as a result of air restrictions on teepee burners, can result in leaching of organic pollutants into aquatic systems. Though not a recorded problem in the project area, surface waste disposal has caused domestic well contamination in the Kalispell area.

Production of posts and poles can degrade ground water during disposal wood wastes and loss of creosote and other preservatives. However, such problems have not been documented to date. Similarly, production of plywood and fiberboard can pollute ground water with leachate from wood and liquid wastes containing adhesives.

The only paper product operation in Montana is the Hoerner-Waldorf plant near Missoula. As part of the operation, wastewater is disposed of in 750 acres of storage and seepage ponds. The plant discharges 15.8 mgd of liquid wastes into these lagoons. The percolating effluent has created a ground-water body under and peripheral to the storage ponds. Though this waste water contains odor, taste, and color-producing compounds, it appears to be confined to the shallow aquifer in the area and there have been no documented cases of ground-water degradation.

solid waste--There are 203 waste disposal sites in the Statewide 208 area. Dominant refuse at most sites is normal community wastes. Potential pollution from landfills is a function of moisture, refuse material, vegetation, time, and management operations.

Leachate from landfills has been shown to percolate down to the ground-water table. In Montana, there have been two detailed investigations of ground-water pollution from landfills, Livingston, and West Yellowstone. In both cases, leachate showed an increase in dissolved solids, specific conductance, and COD. Leachate from the Livingston dump also had higher values for hardness, alkalinity, chloride, potassium, and total organic carbon while the West Yellowstone dump's percolate had increased carbon dioxide, lead, iron, and manganese. Leachate from both sites had reached subsurface aquifers.

During the summer of 1977, the Solid Waste Management Bureau examined 34 disposal sites for ground-water pollution potential. Table 30 summarizes this study.

sanitary waste--Several potential problems are associated with sanitary waste disposal. In particular, increases of nitrogenous compounds and total dissolved solids and contamination by microorganisms, organic compounds, and metals are problems most frequently encountered.

Municipal disposal systems in the Statewide 208 area consist of 20 sewage treatment plants and 102 treatment lagoons. There are few data on ground-water impacts of treatment plants, and no problems have been reported in the Statewide 208 area.

Lagoons are widely used by small communities and isolated industries. Again, little information exists on actual impacts of lagoons on ground water, but the main concern is the movement of nitrate into ground water. Researchers speculate that a body of polluted ground water forms beneath lagoons and is a potential threat to receiving systems. However, areas around lagoons are generally uninhabited and no problems have been reported in Montana.

Once treated, liquid wastes are generally discharged into surface waters; however, increasing population and increasing loads to streams have resulted in land disposal becoming more popular. There are land disposal systems operating in Missoula, Gregson Hot Springs, Great Falls, and Helena. Land application of wastes is apparently very effective and no resulting ground-water problems have been noted; however, nitrate contamination is possible.

Rural domestic waste disposal consists of septic tanks with drain fields, cesspools, or septic tanks with seepage pits. A majority of the systems are septic tank/drain fields. Potential septic tank impacts on ground water are similar to those of lagoons and land disposal. Nitrate increases are the most frequently encountered problem; however, bacteria and virus contamination also often result.

TABLE 30

POLLUTION POTENTIAL OF THIRTY-FOUR SOLID WASTE SITES IN THE STATEWIDE 208 AREA

| Community | Groundwater Pollution Problems |
|---|---|
| Alder | Groundwater pollution during spring runoff and high seasonal groundwater. No control of septic tank pumpings or hazardous wastes |
| Anaconda | Infiltration of runoff and formation of leachate |
| Butte | Slight pollution potential from infiltration of runoff |
| Cascade | Possible long-term groundwater pollution problem due to infiltration of precipitation |
| Choteau | Slight potential for groundwater pollution due to infiltration of precipitation |
| Conrad | Minor pollution potential due to infiltration of precipitation |
| Cut Bank | Very low potential for pollution |
| Darby | Pollution potential possibly high due to creation of leachates |
| Deer Lodge | Very low possibility of pollution |
| Dillon | Slight potential for pollution |
| East Helena | Very low potential for leachate production |
| Eureka | Low to moderate pollution potential from leachate/groundwater contact |
| Fresno | Intense use of pesticides in this area may lead to disposal in the Havre sanitary landfill which is in the Havre water supply basin. Pollution potential high enough to recommend closing or relocating the site |
| Glasgow | Low pollution potential, but additional studies needed |
| Great Falls | Some pollution potential due to infiltration of precipitation and creation of leachate |
| Havre | Low pollution potential |

| Community | Groundwater Pollution Problems |
|---|---|
| Helena | Low to moderate pollution potential |
| Helena (Scratch Gravel Site) | Low pollution potential |
| Lewistown (Harfort) | Low pollution potential |
| Lewistown (Mintyala) | Low pollution potential |
| Libby | Low pollution potential |
| Lima | High pollution potential due to infiltration and high water levels |
| Livingston | High pollution potential |
| Lozeau | Low to moderate pollution potential |
| Missoula (City Disposal) | Low potential |
| Plentywood | Low pollution potential |
| Sand Coulee | High pollution potential |
| Shelby | Low pollution potential |
| Sheridan | High pollution potential due to high seasonal groundwater |
| Sidney | Low pollution potential |
| Stanford | High pollution potential due to high groundwater |
| Ulm | Uncertain pollution potential |
| Victor | Moderate to high due to infiltration of precipitation |
| Wolf Point | Low potential |

There is no accurate estimate of the number of individual septic tank systems in Montana and no attempt has been made to quantify or qualify their impacts on ground water.

Community septic tank systems associated with subdivisions have received some attention. The interest has been stimulated by the rapid increase of subdivided areas (Table 31). Land division has been most active in Mineral, Missoula, Ravalli, Deer Lodge, Jefferson, Lewis and Clark, Powell, Cascade, Park, and Musselshell counties in the Statewide 208 area.

TABLE 31

SUBDIVISION GROWTH IN MONTANA

| Year | Subdivisions Approved | Acres Subdivided |
|---|---|---|
| FY 75-76 | 915 | 6,204 |
| FY 76-77 | 1578 | 9,430 |
| FY 77-78 | 2768 | 14,970 |
| FY 78-79 | 3447 | 18,410 |

The figures in Table 31 include only subdivisions approved by DHES. Many others are denied or are exempt from review. DCA has estimated 93 percent of all subdividing has occurred outside the review process.

With increasing subdivision activity and limitations of the review process, regulations of domestic waste disposal is of major concern. Five suspected problem areas in the Statewide 208 area have been examined to date. The Helena valley is an area with widespread usage of septic tanks and individual wells. Ground water is shallow in the valley and most wells are only 25-60 feet deep. Health concern prompted the USGS to sample wells in the valley in 1973 and 1974 for possible contamination. Tests showed the ground water to be of good quality and uncontaminated by domestic waste. However, development of the valley is rapidly increasing and population is expected to reach 4,000 by 1990. It is likely contamination is just a matter of time unless future development is strictly regulated.

A minimal amount of sampling in a mobile home court southwest of Great Falls showed a substantial amount of water was put into the ground-water system by septic tanks. Though it was suspected some pollution may have occurred, it was not quantified.

The old community of Melrose, on the Big Hole River, has had health problems in the past as a result of waste contamination. In addition to being located on coarse gravel over a shallow ground-water system, most wells are improperly sealed and located within 50 feet of drain fields or cesspools.

Lincoln also has a high ground-water table and rapid growth has caused concern for well contamination. Even though sampling in 1974 showed no contamination, concern may be justified with future growth.

Libby Flats near Libby has recently experienced contamination of wells. The five subdivisions in the area are located on sandy soils over high ground-water tables. In addition, the area is a designated flood plain. Continual growth of the area may warrant a community disposal system in the future.

The significant potential threat of subdivisions on ground-water systems prompted the technical study described in a following section. Basically, the study will attempt to quantify subdivision impacts and recommend statewide measures to control the problem.

<u>storage reservoirs</u>--There is strong evidence to indicate that reservoirs do enhance movement of water into ground-water systems and can, as a result, change the quality of those systems.

There are about 250 reservoirs in the state with a total surface area of about 1,000,000 acres. Most of the impoundments are not lined and it is likely a substantial amount of water is entering the ground. The process of evaporation often increases salinity of the stored waters, particularly in smaller ponds, and this percolating water could degrade receiving aquifers as well as streams. However, no in-depth investigation of reservoir impacts has been made in Montana. Though aerial surveys have shown saline deposits in stream channels downstream from reservoirs, no specific degradation problems have been reported.

## POINT SOURCE EVALUATION

The WQB's Construction Grant and Waste Discharge Permit Programs are effectively managing point source pollution in Montana. Currently, less than 100 stream miles are degraded by point source pollution and these problems are expected to be easily eliminated by 1983.

The Construction Grant Program is based on a priority system for fund allocation since community needs outweigh available funds. The system considers sewage treatment to be of the highest priority except in cases of extreme public health hazard. The annually revised priority list contains all projects expressing a need; grant monies are obligated to top priority projects until funding is expended. Table 32 lists projects in the Statewide 208 area that were ranked in the FY 1978 Priority List. The priority totals are based on stream segment designation, water use classification, population, and scope of the project in abating pollution. The Butte project was highest on the 1978 priority list.

TABLE 32

CONSTRUCTION GRANT PROJECTS IN THE STATEWIDE 208 AREA

| Community | Priority Total | Grant Step |
|---|---|---|
| Butte-Silver Bow Co. | 63 | 3 |
| Eureka | 54 | 3 |
| Three Forks | 54 | 1 |
| Stevensville | 53 | 3 |
| Thompson Falls | 49 | 3 |
| Havre East | 47 | 2 |
| Anaconda | 45 | 1 |
| Livingston | 44 | 2 |
| Dillon | 44 | 1 |
| Libby | 44 | 1 |
| Hamilton | 44 | 1 |
| Choteau | 44 | 1 |
| Townsend | 44 | 1 |
| Boulder | 44 | 1 |
| Plains | 44 | 1 |
| Whitehall | 44 | 1 |
| Lolo | 43 | 1 |
| Sheridan | 43 | 1 |
| Sunburst | 43 | 1 |
| Darby | 43 | 2 |
| Drummond | 43 | 1 |
| Hobson | 43 | 1 |
| Cooke City - Silvergate | 43 | 1 |
| Lewistown | 42 | 1 |

| Community | Priority Total | Grant Step |
|---|---|---|
| Harlowton | 42 | 1 |
| Chester | 41 | - |
| Roy | 41 | 1 |
| Rocker | 41 | 1 |
| Deer Lodge | 40 | 1 |
| Wolf Point | 40 | 1 |
| Chinook | 40 | 1 |
| East Helena | 40 | 1 |
| Cut Bank | 39 | 1 |
| White Sulphur Springs | 39 | - |
| Big Sandy | 39 | - |
| Gildford | 39 | 1 |
| Malta | 38 | 1 |
| Warm Springs | 38 | 1 |
| Sweetgrass | 38 | - |
| Great Falls | 36 | 1 & 3 |
| Valier | 36 | - |
| Winnett | 36 | 1 |
| Judith Gap | 36 | - |
| Sidney | 35 | 1 |
| Harlem | 35 | 1 |
| West Glendive | 35 | 1 |
| Plentywood | 35 | - |
| Fairview | 35 | 1 |
| Power-Teton County Water Assn. | 35 | 1 |
| Circle | 34 | 1 |

| Community | Priority Total | Grant Step |
|---|---|---|
| Terry | 34 | 1 |
| Stanford | 34 | - |
| Denton | 34 | - |
| Saco | 34 | - |
| Dodson | 34 | - |
| Savage | 34 | 1 |
| Fairfield | 32 | - |
| Nashua | 32 | - |
| Cherry Creek RID (Glasgow) | 32 | - |
| Missoula Sewers | 31 | 1 & 3 |
| Willow Creek | 30 | 1 |
| Dillon Sewers | 29 | - |
| Troy | 29 | - |
| Livingston Sewers | 28 | - |
| Lolo Sewers | 28 | - |
| St. Regis | 28 | - |
| Corvallis | 28 | 1 |
| Ulm | 28 | - |

The grant process is divided into three steps:

1. Facilities planning is a detailed planning effort to solve particular community problems. Existing systems are analyzed, growth and development trends are projected, and treatment alternatives are analyzed, and a recommended solution is derived.

2. System design is initiated if the Step 1 process is approved; plans and specifications of a selected treatment system are prepared.

3. Construction obviously incorporates the major portion of the project costs. Table 32 indicates the step each project had achieved at the time of this writing.

The Montana Pollutant Discharge Elimination System (MPDES) has all major significant point source dischargers under permit. Those in the Statewide 208 study area are shown in Table 33. The WQB undertakes active compliance inspection to insure that permit conditions are being obtained.

## SPECIFIC TECHNICAL STUDIES

As a public health oriented agency, the Water Quality Bureau's emphasis in the past has been on point source pollution. Consequently, there are relatively few data available which adequately identify the nature and extent of nonpoint source problems in Montana. The Statewide 208 project has attempted to fill this data gap by initiation of several technical studies designed to show the extent of nonpoint source problems in the study area, determine what types of pollutants were most prevalent, and illustrate the relationship between land use and nonpoint source pollution.

Some of the studies have been recently initiated and will require continuation in the next year to meet their objectives. In other cases, a one-year study simply was not sufficient to meet intended objectives and these projects will be continued for at least another year and may ultimately become part of the Bureau's regular monitoring program.

The objectives, results, and recommendations of each study are summarized in the following text. For a more detailed account of the projects, the reader is referred to the project's specific report listed in the Bibliography.

### BIG HOLE RIVER STUDY

Many streams in the Statewide 208 area are adversely affected by excessive dewatering. Though some of the dewatering is attributable to natural

TABLE 33

MPDES PERMITS IN THE STATEWIDE 208 AREA

| Discharger | Basin |
|---|---|
| Municipal | |
| Dillon | Upper Missouri |
| Missoula | Lower Clark Fork |
| Silver Bow Metro | Upper Clark Fork |
| Hamilton | Upper Clark Fork |
| Deer Lodge | Upper Clark Fork |
| Livingston | Upper Yellowstone |
| Great Falls | Missouri-Sun-Smith |
| Helena | Missouri-Sun-Smith |
| Havre | Milk |
| Glasgow | Milk |
| Glendive | Lower Yellowstone |
| Libby | Kootenai |
| Conrad | Marias |
| Cut Bank | Marias |
| Lewistown | Middle Missouri |
| Wolf Point | Missouri-Fort Peck |
| Non-Municipal | |
| Anaconda Company | Missouri-Sun-Smith |
| Phillips Petroleum Company | Missouri-Sun-Smith |
| Anaconda Company (2 discharges) | Upper Clark Fork |
| Hoerner Waldorf Corporation | Lower Clark Fork |
| T. R. Daily | Lower Clark Fork |
| St. Regis Paper | Kootenai |

losses, irrigation withdrawals are the primary cause of decreased water levels. Though flow reduction is common to many streams, the effects on water quality are poorly understood. In an effort to document the effects of flow reductions, the Water Quality Bureau initiated the Big Hole River Study.

The Big Hole River, a nationally known Blue Ribbon trout stream, has periodically experienced low flows due to irrigation withdrawals. Though possessing a prime fishery in the past, Department of Fish and Game surveys indicate a diminishment of aquatic habitat to the point that the fishery is described as average at best. Since the Big Hole River has exhibited extreme dewatering in the past and since meterological data in Spring of 1977 indicated the summer would see drought in southwestern Montana, the Big Hole River was chosen for the study.

The study consisted of two aspects. The technical aspect was intended to document water quality impacts of depleted stream flows in the Big Hole River at its mouth near Twin Bridges. Appropriate biological, physical and chemical parameters were measured periodically during the 1977 irrigation season. These data were to provide support to the study's other aspect--education. For this part of the study, the Bureau intended to produce a color film documenting the effects of irrigation drawdown in the Big Hole River. The film is discussed in the Public Participation section.

<u>Land Use and Water Quality</u>

The Big Hole River (Figure 5) drains 6,413 km. (2,476 square miles). Cattle grazing and hay production are major land uses in the drainage. The number of irrigation diversions between Divide Dam and the mouth of the Big Hole River increased from 26 in 1970 to 44 in 1973. It is this portion of the stream which is a nationally recognized trout fishery. The WQB considers the Big Hole River to be of generally excellent quality except for periodic excessive stream temperatures expected to be due, at least in part, to irrigation withdraws.

<u>Effects of Dewatering</u>

The initial effect of dewatering is, obviously, reduction of aquatic habitat. The loss is reflected not only in available space for fish and other aquatic organisms but in the stream's primary productive capacity. Bahls (1978) estimated that when one square meter of Big Hole River bed becomes dry, about one third of a gram of algal production is lost for each day of exposure. In terms of fish loss, this represents about 0.03 pounds for every day an acre of river bottom is exposed, or about 11 pounds per year.

Subsequent to the initial impact of habitat loss, dewatering effects several water quality changes. In the case of a trout stream such as the Big Hole River, rising temperature due to dewatering is a most lethal impact. During 1977, maximum daily temperatures that exceed the upper limit for optimum growth of brown trout (17$^{o}$C) were recorded almost consecutively from June first to mid-September in the Big Hole River. Though maximum temperatures known to be lethal to brown trout (23.5$^{o}$C) were not observed in 1977, a peak


Figure 5. Big Hole River drainage.

of 23.4°C was recorded in August. Higher temperatures have been recorded in the past. It is likely these elevated temperatures are accompanied by dissolved oxygen decreases which would certainly have a detrimental impact on fish populations.

In addition to temperature increases, specific conductance, calcium, sulfate, and other common chemical parameters tend to increase during dewatering. Specific conductance in the Big Hole River increased from 186 $\mu$mhos/cm to 283 $\mu$mhos/cm during the 1977 irrigation season.

According to the 1977 summer data, the Big Hole River is nitrogen limited during the irrigation season. With cultural additions of inorganic nitrogen to the river, increased algal growth could be expected. This, coupled with flow reductions and increasing temperatures, could result in critical dissolved oxygen problems in the river.

The lower Big Hole River did not become critically dewatered during 1977 as anticipated. Though some late summer rains helped maintain flows, it is possible irrigation itself was responsible for the river's relative well-being. When drought threatens in the lower Big Hole River Basin, ranchers begin flood irrigating much earlier than in normal years--April rather than around May 15 to June 1. Though this would seem to insure reduced flows in the stream, ranchers believe that heavy application of water in early spring serves to recharge ground-water systems and sustain surface flows during dry summer months. Though there are not yet sufficient data to confirm the aluvial recharge theory, it is a likely possibility in the lower Big Hole River Basin at least. A commonly accepted practice to reduced dewatering is to change from flood to sprinkler irrigation systems. Certainly, in the case of the Big Hole River at least, the environmental effects of flooding vs. sprinkler irrigation need to be carefully examined.

Although the Big Hole River study has probably asked more questions than it answered, it has served to emphasize the close relationship that exists between water use and water quality. Further, the relationship can be very unique to one system and is not conducive to broad generalization. In view of the Big Hole River's importance and its uniqueness, additional study is not only warranted but would be of value.

## NORTHERN BOULDER BATHOLITH STUDY

The Boulder Batholith (Figure 6) has, in the past, experienced intense mining activities. The primary objective then was gold, leaving behind ores laden with zinc, copper, silver, lead, and other metals.

Increasing demand and prices for gold and other base metals have renewed mining interest in Boulder Batholith. In an effort to quantify the relationship between mining and water quality, the WQB initiated the Boulder Batholith study to take advantage of potential developments in the area and obtain data on existing conditions. Four drainages in Batholith were examine during the summer of 1977. Aerial and ground surveys were used to locate and describe mines, adits, tailings, dumps, and receiving streams. Waters in the drainages were analyzed for flow rate, pH,

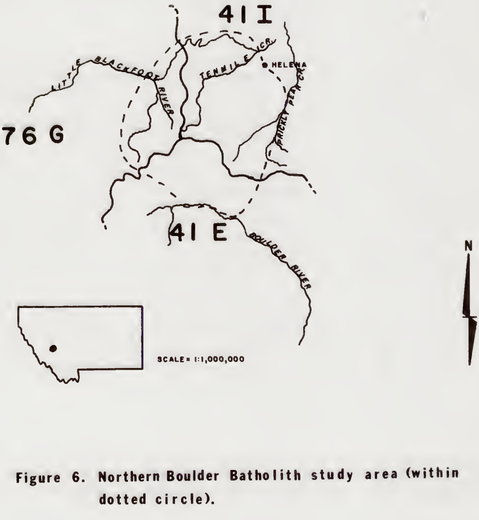


**Figure 6.** Northern Boulder Batholith study area (within dotted circle).

conductivity, sulfate, silver, arsenic, cadmium, copper, iron, mercury, manganese, lead, zinc, and periphyton composition.

Nearly all streams in the study area are affected by past and current mining activities. Fifty-six of 66 stream sample sites had metal concentrations exceeding those known to adversely affect aquatic organisms. Some streams were being severely stressed by acid mine drainage.

Boulder River Drainage

The Boulder River Drainage is well documented as having degraded water quality due to mine waste.

"Toxic metals discharged from mine seeps upstream of Boulder, Montana, are present in the Boulder River in concentrations reported to cause avoidance reactions to migrating fish, thus, blocking existing or potential spawning runs from downstream. Fish food production, fish growth, and spawning success are inhibited severely in some tributaries in portions of the Boulder River. Water quality impairment is due principally to input of sediment and toxic metals from the High Ore and Cataract Creek drainages (Braico and Botz, December, 1974)."

The Boulder River above Basin is relatively free from mining-related pollution. Basin Creek carries an appreciable amount of iron and zinc, probably due to seeps from the Josephine Mine near Clear Creek and the Morning and Bullion Mines near Jack Creek.

The Crystal Mine severely impacts Uncle Sam Gulch and lower Cataract Creek. "Aquatic insects were not present in Uncle Sam Gulch below the Crystal Mine and were not found in Cataract Creek 3 miles below the confluence with Uncle Sam Gulch (Elser and Marcoux, April, 1972.)" The Eva May Mine also contributes a metal load to Cataract Creek.

High Ore Creek is sterile below the Comet Mine. The stream flows through old mine tailings picking up sediment and heavy metals.

In comparing parameter concentrations and recommended limits, all sites except for Boulder River above Basin, Basin Creek at Winters Camp, Jack Creek above and below Vindicater Mine, and Basin Creek above the reservoir, had metal concentrations exceeding those known to cause an impact on aquatic organisms.

Prickly Pear Creek Drainage

Prickly Pear Creek and Clancy Creek were sites of intense placer mining activity for many years. Stream beds have been severely disturbed and covered with sediment. Abandonment of placer mines years ago has allowed these two streams to naturally recover to some extent.

Spring Creek is severely impaired by mine waste and contributes a tremendous load of sediment and heavy metals to Prickly Pear Creek.

Spring Creek is stressed by mine seeps from Alta Mountain, Wood Chute Creek, and the Washington Mine. A small stream flowing through tailings piles dumped in Corbin severely impacts Spring Creek below that town.

Gregory Mine and many smaller mines deliver an appreciable amount of pollutants to upper Clancy Creek. Observations indicate Clancy Creek contributes a pollutant load to Prickly Pear at certain times of the year.

Even though the Froehner and Nellie Grant Mine seeps flow into the headwaters of Lump Gulch Creek and have an impact on these headwaters, the stream appears to be unstressed in its lower reaches.

Ten Mile Creek Drainage

Upper Ten Mile Creek and its tributaries were relatively pollution free at the time of sampling. Seeps from two mines, Porphry Dike and Peerless, have a slight influence on the upper reaches of Ten Mile Creek. These problems would be especially prevalent during spring runoff.

The most drastic pollution problems in the Ten Mile Drainage were observed in and very near Rimini. A seep from the mine above Rimini flows into Ten Mile Creek about one-quarter of a mile above the City of Helena's water diversion. This mine and the three mines (Grant, Lee Mountain, and Valley Forge) in Rimini, degrade Ten Mile Creek for a number of miles downstream.

The Justice Mine seep near upper Minnehaha Creek is very concentrated in metals and acid. Even though the seep went underground before reaching the creek, the effects were noticed (e.g., zinc concentration of .34 mg/l at the mouth of Minnehaha Creek). During period of high runoff, one can expect concentrations of metals and acid in Minnehaha Creek to increase. Minnehaha Creek is also a source for Helena's drinking water.

With the exception of Grizzly Gulch, lower Ten Mile Creek and its tributaries appeared unstressed by mine related pollutants. Grizzly Gulch is impaired by sediment and iron.

Little Blackfoot River Drainage

With the exception of the headwaters of Telegraph Creek, the Little Blackfoot River and its tributaries are relatively free from pollution. Lily-Orphan Mine has degraded two to five miles of Telegraph Creek.

Most mine seeps in the drainage are in an area where they do not flow into any stream. This appears to be the reason why stress on waters in the Little Blackfoot Drainage are minimal.

Large mining companies and many small miners are actively exploring and mining in the Northern Boulder Batholith. Some operations are using existing adits, tailings, and dumps. Most abandoned mine shafts have since filled with ground water having low pH and high concentrations of

metals. Future use of such shafts will require removal of this contaminated water which could severely degrade receiving streams.

Confidentiality between small miners and the Department of State Lands makes it impossible for the WQB to advise miners on the control of wastes unless so requested. The most the WQB can do at this point is to continually monitor receiving waters in order to be in a better position to advise miners of necessary control measures should the Hard Rock Law be revised to include DHES.

## SILVER BOW CREEK STUDY

Silver Bow Creek has long been considered to be a biological desert, due mainly to heavy metal pollution from mining. In recent years, the Anaconda Company has expended a considerable effort in restoration of the stream. Though numerous studies have examined water quality improvements in Silver Bow Creek and the Clark Fork Drainage, few have dealt with chemical characteristics, particularly in Silver Bow Creek.

During the summer of 1977, the WQB contracted with Montana State University for sampling of 21 stations in the Upper Clark Fork drainage (Figure 7). In addition to taking flow measurements and temperature readings at the sites, samples were analyzed for pH, specific conductance, cadmium, copper zinc, nitrogen, ammonia, nitrate, and phosphorous. Anaconda Company smelter discharges were the major sources of metal pollution. Particularly high concentrations of zinc and copper were being discharged to the Opportunity Ponds (Table 34). Anaconda Company was on strike for a period during the study.

TABLE 34

HEAVY METAL POLLUTION FROM ANACONDA COMPANY SMELTER

| Metal | Site | Range kg/day | Average kg/day |
|---|---|---|---|
| Zinc | 15 | 1.67 - 3348 | 995 |
| | 16A | 15.75 - 105 | 59 |
| Copper | 15 | 7.62 - 8658 | 2290 |
| | 16A | 8.22 - 2745 | 800 |
| Cadmium | 15 | 0.07 - 4.92 | 1.10 |
| | 16A | 0.36 - 6.29 | 2.44 |

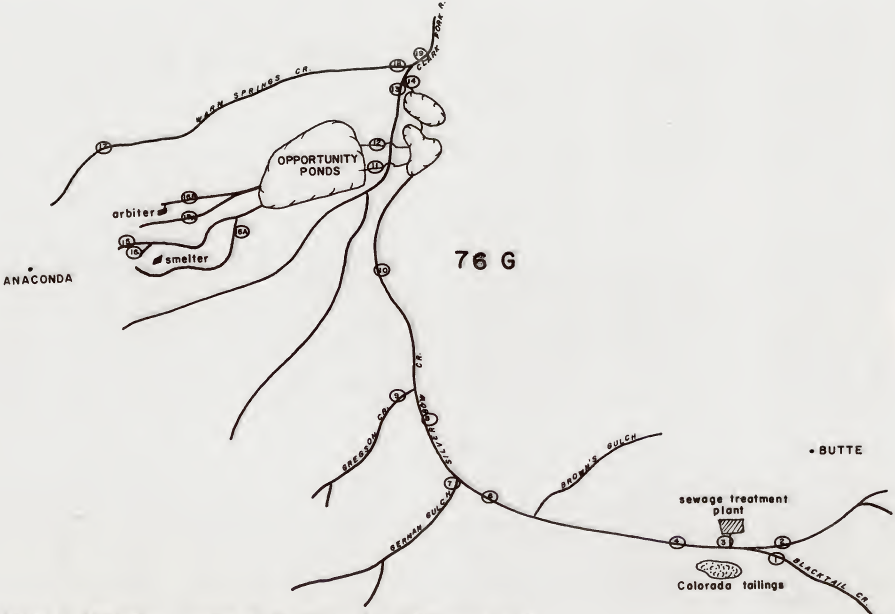


Figure 7. Schematic diagram of the Silver Bow Creek study area.

Table 35 compares water quality before the strike and just prior to start-up of plant operations.

TABLE 35

COMPARISON OF SMELTER DISCHARGE QUALITY
BEFORE AND AFTER COMPANY STRIKE (SITE NO. 15)

| Metal | Average of 3 runs before strike | Average of 6 runs after strike |
|---|---|---|
| Zinc | 6.76 | 1414 |
| Copper | 76.58 | 3397 |
| Cadmium | 0.34 | 1.48 |

Stream data above and below the Colorado tailings indicate large amounts of zinc (145.34 kg/day), moderate amounts of copper (11.37 kg/day), and small quantities of cadmium (1.17 kg/day) are leaching into Silver Bow Creek.

The Butte Metro sewer and raw sewage ditches from Anaconda are major sources of nutrients; as much as 611 kg/day of Kjeldahl nitrogen and 216 kg/day of orthophosphate were recorded at site No. 3.

Though the potential for stream pollution in the study area is substantial, the Opportunity and Warm Springs ponds are highly efficient in removing nutrients and heavy metals (Table 36).

TABLE 36

SETTLING EFFICIENCY OF OPPORTUNITY AND WARM SPRINGS PONDS

| Parameter | % Removed - Opportunity Pond | % Removed - Warm Springs Ponds |
|---|---|---|
| Cadmium | 92.2 | 69.0 |
| Copper | 99.9 | 91.3 |
| Zinc | 99.7 | 98.2 |
| Kjeldah Nitrogen | 94.8 | 78.0 |
| Ammonia | 95.7 | 94.3 |
| Nitrate + Nitrite | 83.4 | 83.5 |
| Total Phosphorous | 99.9 | 93.4 |
| Orthophosphate | 94.1 | 95.0 |

## STORMWATER RUNOFF

The desk-top assessment of stormwater runoff pollution (described in a previous section) is a workable screening tool for identifying potential problems; as such, it is the first step necessary in a comprehensive assessment of statewide stormwater pollution. The next steps, problem quantification and correction, have been recently initiated through a contract with Wright-McLaughlin Engineers. Two cities, Helena and Anaconda, were identified in the initial assessment as potential problems, and are the sites for a detailed study of actual stormwater runoff conditions. Objectives of the study are to quantify specific water quality impacts in the two basins, apply the impacts on a statewide basis, and develop general statewide guidelines for dealing with stormwater runoff.

In addition to any existing water quality data, runoff from both communities is being sampled during summer storm events and spring runoff. The samples are being analyzed for nutrients, metals, BOD, and sediment. These data will be evaluated to detect special water quality problems and, through use of a computer model, predict pollutant loadings under present and future conditions. Data to be used in the model are listed in Table 37. Subsequent to data evaluation, various structural and management alternatives will be reviewed for effectiveness in eliminating the impacts to receiving waters.

The assessment's ultimate step, and most difficult one, will be to compare runoff data and model results with statewide urban runoff problems. Since most urban situations are unique in one or more characteristics, the comparison may be superficial; however, the model will at least have been tried in one of the most difficult situations with Anaconda. The area has a variety of land uses, including extensive mining operations, which contribute in various degrees to the runoff problem. If the model can effectively predict pollutant loadings in Anaconda, hopefully it will be usable statewide.

Once stormwater impacts have been identified, control and abatement guidelines will be developed. Though the guidelines will be oriented towards both prevention and remedial measures, a major emphasis will be placed on the preventative aspect to avoid creation of future storm water runoff pollution problems. In view of the state's growth potential, a strong preventative program for storm water runoff pollution will represent a significant water quality achievement in Montana.

TABLE 37

DATA USED IN URBAN STORMWATER RUNOFF COMPUTER MODEL

| |
|---|
| Precipitation |
|     1, 2, and 10-year storms |
|     Highest 30-minute intensity |
|     Evaporation rates |
| Channel/storm Sewer Specifications |
|     Slope direction |
|     Length |
|     Depth |
|     Roughness |
|     Pipe size |
| Catchment Characteristics |
|     Width |
|     Area and volume |
|     Percent imperviousness |
|     Slope |
|     Surface resistance |
|     Detention depth |
|     Infiltration rates |
| Runoff Quality Data |
|     Number of days since last rain |
|     Average BOD in catch basin |
|     Exponential coefficient of pollutant washoff |
|     Street sweeping frequency |
|     Dust and dirt loading |
|     Concentration of selected quality parameters |
|     Amount of suspended solids |
|     Erosion data |
| Land Use |
|     Types of land use |
|     Total gutter length |

## SUBDIVISION GROUND-WATER POLLUTION

Though subdivision construction results in surface runoff problems, these impacts can be minimal and short term with proper practices. A more critical quality threat from subdivision development is pollution of ground water by subsurface disposal systems.

The preliminary subdivision assessment, described in a previous section, evaluated the pollution potential of 32 major subdivisions in the Statewide 208 area. That study's major objective was to subjectively evaluate several developments and rank them according to potential for causing ground-water pollution.

Using that study's results, a more in-depth evaluation of subdivision pollution was initiated in July, 1978. Five of the top priority subdivisions listed in the preliminary report were selected for ground-water monitoring. South Libby Flats, number one priority, and Opportunity, number three priority, were not selected because of planned or on-going studies of a similar nature in those areas. The five subdivisions to be evaluated are: Sewell's Addition No. 4 and Lambkins (Lewis and Clark County), H & R Addition and Hawken Lane Estates (Ravalli County), and Five Acre Tracts (Park County).

Existing and new wells and sandpoints will be used to obtain water samples which will be analyzed for fecal coliforms, chemical oxygen demand, nitrate, ammonia, TDS, chlorides, and pH. At least five sites in each development will be sampled bimonthly in the next year.

Depending on sampling results, additional analyses may be performed in these subdivisions and should the information prove valuable, other developments listed in the preliminary report may be added to the monitoring program. The objective is to use these new and any existing data to quantify the actual effects of subsurface disposal systems on ground water.

The monitoring data will then be the basis for an evaluation of the effectiveness of existing guidelines or regulations for the protection of ground-water systems and development of management programs to deal with existing problems.

## BIOLOGICAL MONITORING

The following discussion is extracted from the report "Biological Water Quality Monitoring in Southwest Montana, 1977-1978" (Bahls, et al., 1978).

The national goal of fishable and swimmable water by 1983 presumes that basic biological communities and processes that permit these uses are maintained in a healthy balance. For example, it presumes that the small aquatic animals that fish eat will be present in variety and abundance, and it presumes that algae will not become a nuisance to boating, swimming,

and fishing. Until recently, basic biological processes such as photosynthesis and aquatic life forms lower than fish had been given little consideration in water quality planning and management, yet these processes and life forms are basic to the integrity of the entire aquatic ecosystem. Any effects here on the "ground floor" likely will have repercussions on up the food chain.

Chemical and physical properties of water affect living organisms in ways we are just beginning to understand. Aquatic organisms are capable of integrating the many and diverse factors of their environment and of expressing their combined effect in terms of growth, reproductive success, and genetic diversity. Aquatic organisms are known to be differentially sensitive to various pollutants, hence some of the more sensitive and tolerant taxa have become useful as water quality indicators. Lower life forms are particularly useful as indicators because they are almost always present in statistically significant numbers.

To maintain water quality for fish and aquatic life is public policy of the State of Montana [Sec. 69-4801 (1), R.C.M. 1947]. Pollution is defined in part as "contamination, or other alteration of the physical, chemical, or biological properties of any state..." [Sec. 69-4802(5), R.C.M 1947]. If we are to measure our success at protecting aquatic life and controlling pollution, we need a good yardstick. What better yardstick than the biological organisms and processes themselves? Yet there has been no comprehensive, systematic, and continuing biological monitoring to date in Montana.

The Montana Biological Monitoring Program is designed to help fill this need. The program consists of a network of stations, a battery of parameters, and a sampling strategy.

The network includes 79 stations on 60 streams statewide, selected from completed water quality inventories and management plans (Water Quality Bureau, 1976) on the basis of likely improvement or degradation of water quality. Sites monitored for biological parameters by the U.S.G.S. were considered in station selection in order to complement state and federal programs. Stations are grouped geographically into five loops, each with about 16 stations (Figure 8).

Data are gathered for seven biologically-related parameters: streamflow, common ions (including specific conductance and total alkalinity), algal nutrients, algal growth response to nutrient additions (algal assay), periphyton production, periphyton community structure, and macroinvertebrate community structure.

Stations are monitored seasonally, once in summer, once in fall, and once in spring. Ice has proven to be a serious impediment to sampling, expecially to flow gaging, periphyton production measurements, and macroinvertebrate collecting. Consequently, winter sampling will not be pursued, even though it is a season of stress for aquatic organisms.

STATE OF MONTANA

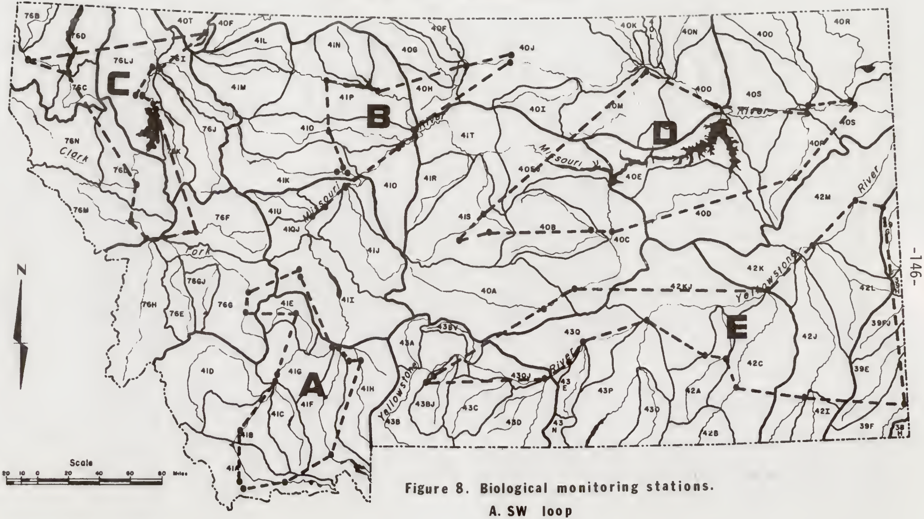


Figure 8. Biological monitoring stations.

A. SW loop

B. NC loop

C. NW loop

D. NE loop

E. SE loop

Realistically, with available manpower, only one or two loops can be monitored each year, hence each loop will be resampled every fourth or fifth year. Subsequent reports will evaluate changes in water quality over the intervening periods. Obviously, the program is not designed for rapid detection of acute problems but rather for evaluation of chronic, long-term trends.

The Southwest Loop was the first to be sampled in the biological monitoring program. This loop includes some of the most popular and productive cold water fisheries in Montana. Also represented is a nearly complete cross-section of Montana water quality problems: sediment, temperature, dewatering, nutrients, coliforms, eutrophication, and acid mine drainage. The only major pollutant that is not a serious problem in southwestern Montana is salinity.

All but four of the stations in the Southwest Loop are included in the Upper Missouri Tributaries drainage basin. Two stations, one on Silver Bow Creek and one on the Upper Clark Fork River, are located in the Upper Clark Fork basin. The two stations on Prickly Pear Creek near Helena are located in the Missouri-Smith basin.

Parameters covered are listed in Table 38. All parameters but common ions were collected seasonally, in August or September, 1977 (summer), November or December, 1977 (fall), and March or April, 1978 (spring). Common ions were determined for the summer trip only.

There is clearly a need for consolidating the obtained information so that stations in the Southwest Loop can be compared at a glance and prioritized from the standpoint of management urgency. Two such consolidation schemes are presented below.

Both schemes incorporate mean values for the following key indicators:

1. Specific conductance (micromhos @ 25 C)
2. Total soluable inorganic nitrogen (mg/l)
3. Total phosphorus (mg/l)
4. Algal assay control maximum standing crop (mg/l)
5. Chlorophyll *a* accrual (mg/m$^2$/day)
6. Biomass accrual (mg/m$^2$/day)
7. Autotrophic Index (Biomass accrual/Chlorophyll *a* accrual)
8. Chlorophyll *a*/Pheophytin *a* ratio
9. Carotene/Chlorophyll ratio
10. Percent relative abundance *Achnanthes* species
11. Percent relative abundance *Nitzschia* species
12. Number of diatom species
13. Diatom species diversity ($\bar{d}$)
14. Percent relative abundance intolerant macroinvertebrates
15. Number of macroinvertebrate genera
16. Macroinvertebrate genus diversity ($\bar{d}$)

In scheme A, the assumption is made that the least amount of nutrients and production, whatever the cause, is the most desirable case. All mean values are listed in order from lowest to highest for each indicator.

TABLE 38

PARAMETERS COVERED IN SOUTHWEST BIOLOGICAL MONITORING LOOP

Instantaneous Streamflow ($m^3/sec$)

Common Ions

- Cation Ratio: Ca:Mg:Na
- Anion Ratio: $HCO_3:SO_4:Cl$
- Specific Conductance (micromhos @ 25C)
- Total Alkalinity (mg/l $CaCO_3$)

Algal Nutrients

- $NO_2+NO_3$-N; $NH_3$-N; Kjeldahl-N; $PO_4$-P; Total P (all in mg/l)
- Total Soluable Inorganic Nitrogen ($NO_2+NO_3$-N plus $NH_3$-N): $PO_4$-P Ratio
- TSIN and TOTAL P as % of recommended maximum instream levels (0.35 mg/l TSIN and 0.05 mg/l Total P)

Algal Assay

- Control
  - Mean maximum standing crop (mm5C) (mg/l)
  - Statistic significance of mm5c
  - Limiting nutrient
- Nutrient Spike
  - Mean maximum standing crop (mm5c) (mg/l)
  - Statistical significance of mm5c
  - Limiting nutrient

Periphyton Production

- Chlorophyll *a* Accrual ($mg/m^2/day$)
- Biomass Accrual ($mg/m^2/day$)
- Chlorophyll *a*/Pheophytin *a* Ratio ($OD663_b/OD663_a$)
- Carotene/Chlorophyll Ratio (OD430/OD663)

Periphyton Community Structure

- Rank of diatoms relative to other algae
- Percent relative abundance (PRA) of major diatom species
- PRA *Achnanthes* Species
- PRA *Nitzschia* Species
- Number of diatom species
- Diatom species diversity ($\overline{d}$)

Macroinvertebrate Community Structure

- Mean PRA major macroinvertebrate orders
- Mean PRA tolerant, facilitative and intolerant macroinvertebrates
- Number of macroinvertebrate genera
- Macroinvertebrate genus diversity ($\overline{d}$)

Indicators where the highest value is presumed to reflect the best water quality are numbers 8, 9, 10, 12, 13, 14, 15, and 16 in the list above. Indicators where the lowest value is presumed to reflect the best water quality are numbers 1-7 and 11. The station with the extreme (highest or lowest) value indicating the poorest water quality is given a ranking of one for that indicator. The station with the second highest or lowest value indicating the second poorest water quality is then given a rank of two, and so on until all 17 stations are ranked for that indicator. When all 17 stations have been ranked for each of the 16 indicators, ranks for each station are totaled and divided by the number of indicators measured at that station. The resulting composite rank may be used to assess relative biological health among the 17 stations of the Southwest Loop.

Scheme B presumes that moderate amounts of nutrient enrichment and production are desirable and that too much (eutrophication) or too little (natural sterility or man-caused toxicity) production is not good. Scheme B differs from Scheme A in that production-related indicators (Numbers 2-6) are ranked according to their divergence from the median value, which is considered optimum . In other words, the station with the median value is given a ranking of 17 and the station with the value most distant from the median is given a ranking of one. The remaining indicators which are principally indicators of water quality (Numbers 1, 7, 10, 11, and 14), algal condition (Number 8), and community stability and diversity (Numbers 9, 12, 13, 15, and 16), are ranked as they were under system A.

Composite rankings under the two schemes, arranged in order from lowest (worst quality) to highest (best quality), are presented in Table 39.

Only the Madison River station (MAR) changed significantly in position from one scheme to the other. The Madison had the best water quality under Scheme A, but only the eleventh best water quality under Scheme B. This difference was due to the exceptionally low nutrient and periphyton production values measured in the river at Three Forks which is a function of the river's large macrophyte (higher plant) community tying up nutrients and competing with periphytic algae.

The four stations with the worst biological conditions were the same under both rating systems: East Gallatin River near Belgrade (EGR), Muddy Creek near Dell (MCD), Prickly Pear Creek near Lake Helena (PPL), and Silver Bow Creek below the Warm Springs Ponds (SBC). All four stations are on relatively small streams having limited capacity for assimilating pollution. Three of the four stations are influenced primarily by municipal wastewater discharges and by residual minerals processing waste in the case of Silver Bow Creek. Only Muddy Creek receives no significant wastewater discharge. Thus, its water quality problems are presumed to be diffuse in origin.

On the basis of these composite rating systems it may be concluded that most of the serious biologically-debilitating water quality problems at these monitoring stations derive from inadequate treatment of discrete

TABLE 39

COMPOSITE RANKING OF STATIONS IN THE SOUTHWEST LOOP
(Best possible rank = 17; worst possible rank = 1)*

| Water Quality | SCHEME A | | SCHEME B | |
|---|---|---|---|---|
| | STATION | RANK | STATION | RANK |
| POOR | EGR | 4.8 | EGR | 4.8 |
| | MCD | 6.0 | MCD | 5.4 |
| | SBC | 6.3 | PPL | 5.8 |
| | PPL | 6.8 | SBC | 6.5 |
| FAIR | CFD | 7.9 | RRR | 7.1 |
| | BVR | 8.2 | CFD | 7.6 |
| | RRR | 8.3 | MAR | 8.5 |
| | GRC | 8.4 | GRC | 8.6 |
| | PPE | 9.2 | PPE | 9.2 |
| GOOD | BHR | 9.3 | BVR | 9.8 |
| | JER | 9.6 | JER | 9.8 |
| | SHC | 9.6 | SHC | 9.8 |
| | WFM | 9.8 | WFM | 10.1 |
| | BDR | 10.0 | BHR | 10.2 |
| | WGR | 10.6 | WGR | 10.8 |
| | RUR | 10.8 | BDR | 10.9 |
| | MAR | 11.2 | RUR | 11.8 |

*See page vii for List of Abbreviations

discharges and not from nonpoint sources of pollution. Consequently, installation of technological measures aimed at improving treatment of key municipal wastewater discharges will go a long way toward improving overall water quality in streams of the Southwest Loop. In the case of Silver Bow Creek, the isolation, removal or treatment of residual mine tailings, e.g., the Colorado tailings, may also contribute appreciably to biological recovery.

Conditions at these 17 stations cannot be considered totally representative of overall water quality in southwestern Montana. First, the parameters measured may not reflect the effects of certain forms of

pollution, namely chronic, sublethal metals, high temperature, and dewatering. Second, station selections were made for the purpose of monitoring only the known, more highly visible problems. This resulted in a bias toward the larger, more popular streams. Consequently, the effects of nonpoint pollution in smaller tributary streams are not fairly represented in this survey.

The Southwest Loop is scheduled to be run again in 1981-1982. At that time changes in values of the different parameters can be compared and evaluation of long-term trends in water quality can begin. Meanwhile, the Water Quality Bureau will strive to develop a single, comprehensive, biological water quality index to simplify the rating of streams and the evaluation of trends.

## PROBLEM PRIORITIZATION

Scope of the Statewide 208 project has, for the most part, precluded site-specific problem assessments; study area size and time and funding constraints necessitated a more general assessment. Some of the studies did identify problem stream segments but on the whole, the Statewide 208 assessment has identified general types of surface and ground-water quality problems and the general area of the state where those problems are most significant.

However, critical site-specific problems in the study area will not be ignored. For example, Muddy Creek (Cascade County) has extensive sediment pollution problems and has been identified as a local priority for correction. The Statewide 208 plan will not present a management program designed specifically to correct sediment pollution in Muddy Creek; but sediment pollution in general is a project priority and the Conservation Districts are identified as a likely management agency. Under the Statewide 208 program then, the Cascade Conservation District would be responsible for the problem, determine the causes, decide where responsibility for correction of the problem lies, and, if the problem can be feasibly corrected, see that a solution is implemented. Basically then, although the Statewide 208 project is identifying general problem types, the recommended control programs can be expanded to the practical site-specific level.

Of the two general types of water quality problems, nonpoint source pollution is much more of a management problem than point source pollution. A few point source problems are still occurring, but past management emphasis carried through to today's construction grant and waste discharge permit programs have resulted in effective management of point source pollution.

Conversely, nonpoint source pollution has received relatively little attention; this lack of a comprehensive management program and increasing development of Montana's natural resources have resulted in widespread and severe nonpoint source surface and ground-water quality problems which only promise to increase in magnitude without immediate management.

In Montana, nonpoint source pollution consists of increases in sediment, salinity, toxic metals, nutrients, herbicides, pesticides, and minerals. In addition, excessive reductions of instream flows can alone reduce water quality or intensify a pollution problem. Of these problems, sediment and salinity increases in surface and ground water and stream dewatering are the most extensive water quality problems in the Statewide 208 area and will be the project's highest priorities.

Although any land disturbing activity can result in erosion and sediment pollution, agricultural activities are responsible for a major portion of the sediment problem. Urban development, silviculture, and mining also contribute significant amounts of sediment to the state's waters, but with more than 80 percent of Montana being used for some agricultural endeavor, the magnitude of that industry's impact on water quality is not surprising.

Sediment pollution is ubiquitous in the Statewide 208 study area, but some of the most severely affected streams are in the eastern, more agriculturalized portion of Montana. Similarly, surface and ground-water salinity problems are related to agricultural activities and are also most prevalent in the eastern and northcentral parts of the state. In particular, saline seeps and irrigation return flows are the culprits. Although the degree of adverse salinity impacts on ground water is far from being completely understood, the possibility of extensive ground-water pollution is exceedingly important in light of the ever-increasing use and value of ground-water supplies in Montana.

Extreme dewatering due to irrigation occurs in numerous Montana streams. As with pollution discharges, a certain amount of dewatering must be tolerated in exchange for continuation of an area's economic base. However, excessive dewatering is critically important since it is occurring in or threatens to affect some of Montana's most valuable surface waters, the "Blue Ribbon" (having national as well as statewide value) and "Red Ribbon" (having statewide value) stream segments. So designated by the Department of Fish and Game because of their fishery resource value, these streams also contain some of Montana's highest quality water.

In addition to agricultural pollution (sediment and salinity) and dewatering, numerous other nonpoint source pollution problems must eventually be addressed if the 1983-85 water quality goals are to be met in Montana. In particular, sediment from silviculture, mining, and urban development, acid mine drainage, and subsurface waste disposal are in need of immediate management attention. And ultimately, the impacts of construction and mining exploration and production will need to be addressed.

These problems, then, represent priorities in the Statewide 208 area (Table 40). Subsequent assessments may not only rearrange these priorities but may delete or add problems to the list. The problems are now listed essentially according to extent; additional assessments may reveal economic, environmental, or social infeasibility for correction of a priority problem in a particular area.

TABLE 40

MONTANA'S INITIAL STATEWIDE 208 PROBLEM PRIORITIES

November, 1978

| PROBLEM | CAUSE |
|---|---|
| 1. Sediment - surface water | Agriculture |
| 2. Salinity - surface and ground water | Agriculture |
| 3. Dewatering - surface water | Agriculture |
| 4. Sediment - surface water | Urban development |
| 5. Sediment - surface water | Silviculture |
| 6. Nutrients & pathogenic contamination - ground water | Subdivisions |
| 7. Acid drainage - surface water | Mining |
| 8. Sediment - surface water | Mining |

## REGULATORY FRAMEWORK ANALYSIS AND MANAGEMENT ALTERNATIVES

Although the distinction between Areawide and Statewide 208 programs has been emphasized throughout the preceeding discussions, the difference will be most obvious in discussion of Statewide 208 management programs.

The Areawide 208 projects have essentially identified site-specific pollution problems. Even in those cases where a particular problem may be common to the whole APO area, those study areas are so small, compared to the Statewide 208 area, that management of the problem is still site-specific. For example, sediment pollution in two adjacent counties is much easier to manage than sediment pollution in 25 scattered counties. Thus, Areawide projects are identifying specific management programs while the Statewide 208 project is identifying the mechanisms through which such site-specific problem solving can be implemented.

The following discussion will present several possible means of dealing with the Statewide 208 area's priority water quality problems. Following public review of those alternatives, the final Statewide 208 report will

recommend a water quality management plan which has been identified as capable of correcting the area's water quality problems in the most environmentally and economically feasible and socially acceptable way. The final Statewide 208 report and plan will be released early in 1979 for Governor certification and EPA approval.

## REGULATORY FRAMEWORK ANALYSIS

Since EPA has final approval of the 208 plan, a discussion of the federal requirements for an approvable final plan is in order.

The 1975 federal rules and regulations state: "The plans shall identify the controls, regulatory programs (emphasis added), and management agencies necessary to attain the water quality goals and the established State water quality standards." However, subsequent federal guidance in September, 1977, (SAM-31) stated: "Nonregulatory programs may be approved only where such programs will result in implementation of a nonpoint source program which will result in achievement of desired water quality goals."

In view of the complexity of nonpoint source pollution management, relaxing of the requirement for a regulatory program was probably necessary. An enforceable regulatory program must be able to document a specific water quality impact is resulting from a particular activity and must possess a degree of certainty that a specific change in that activity will correct the problem. In Montana, sufficient data and regulatory authority is lacking to comprehensively enforce a regulatory nonpoint source control program.

At any rate, a nonregulatory program must also meet several criteria in order to receive federal approval. Those criteria are:

- identification of Best Management Practices
- agreement on schedule of milestones
- provision of an effective educational program to inform the public of the requirements
- provision of adequate technical and financial assistance
- agreement to an annual reporting system to EPA's Regional Administrator on progress

Certainly, the most difficult of those criteria to meet will be the financial aspect. In addition, that criterium has created a Catch-22 situation; an approvable plan must show provision of implementation funds but committment of any federal funds, such as through the Rural Clean Water program is contingent upon a final 208 plan being approved. In Montana, implementation of management programs for our most critical water quality problems, i.e., Ag-NPS pollution, will certainly be dependent upon additional funding. Hopefully, that need will not jeopardize water quality management in Montana because of inconsistencies in federal regulations.

The adequacy of existing regulatory authority to control nonpoint source probems was analyzed as a result of the Yellowstone River flow reservation

controversy. The following discussion of Montana's regulatory framework and some of the management recommendations for control of nonpoint source problems in the Statewide 208 area are based, in part, on the report, "The Adequacy of Montana's Regulatory Framework For Water Quality Control" (Jamison, 1978).

Point source pollution in Montana is adequately controlled by the MPDES program which authorizes the issuance of permits for the discharge of point source pollutants. The only real hindrance to the point source regulatory program is the lack of sufficient manpower and funding for comprehensive enforcement activities.

Nonpoint source water quality problems are Montana's greatest obstacles to achieving state and federal water quality goals and have been the emphasis of the Statewide 208 project. Although nonpoint source pollution control is outside the scope of MPDES, the Montana Water Pollution Control Act (MWPCA) and the water quality standards provide the legal authority to the State of Montana for control of nonpoint source pollution. Section 69-480(1)(b), R.C.M. 1947 of the MWPCA states the declared policy of the State is to "provide a comprehensive program for the prevention, abatement, and control of water pollution." Since no distinction is made between point and nonpoint source pollution, this state policy mandates nonpoint source management. In addition, the water quality standards' rule gives DHES the authority to eliminate or minimize nonpoint source pollution. ARM 16-2.14 (10)-S14480(6)(0) states:

> "Pollution resulting from storm drainage, storm sewer discharges, and nonpoint sources, including irrigation practices, road building, construction, logging practices, overgrazing and other practices, are to be eliminated or minimized as ordered by the department."

Authority to adopt a nonpoint source program, therefore, is firmly established by both statute and regulation; however, enforcement authority and capabilities are lacking. Not only is a nonpoint source compliance monitoring network lacking but Best Management Practices are not specifically outlined in the water quality standards. Clearly, having the regulatory authority to adopt a nonpoint source control program means little without enforcement capabilities.

With respect to dewatering, Montana's regulatory authority and management abilities are even more obscure and complex than with nonpoint source management. The water quality standards [ARM 16-2.14(10) S14480(3)] define a dewatered stream as a "perennial or intermittent stream whose water has been removed for one or more beneficial uses." Although the DHES has the authority, under MWPCA, to "prevent, abate, or control the pollution of state waters" Section [69-4820.1 (1)(a), R.C.M. 1947], the scope of this authority is limited to pollutant discharges and alterations of conditions permitted by water quality standards and does not include withdrawal of water. Dewatering may violate water quality standards but the DHES has no control over the amount of water withdrawn for beneficial uses.

The Department of Natural Resources (DNRC) administers the Montana Water Use Act (Section 80-865 et seq., R.C.M. 1947) which determines a person's right to appropriate water. Although the Water Use Act allows denial of a use permit based on water quality degradation at the expense of existing appropriators, DNRC has not denied permits because of possible water quality degradation. DNRC's unwritten policy seems to be that "rights" only include water quantity.

However, two possible legal routes are still available to the DHES for dealing with dewatering: the "Reservation of Water" provision of the Water Use Act (Section 89-890, R.C.M. 1947) and the nondegradation policy of the MWPCA.

The DHES can apply to the Board of Natural Resources and Conservation (BNRC) to reserve waters "for existing or future beneficial uses, or to maintain a minimum flow, level, or quantity of water throughout the year or at such periods or for such length of time as the board designates" [Section 89-890(1), R.C.M. 1947]. However, to be granted a reservation, DHES must establish the purpose of the reservation, establish the amount of water necessary for the purpose of the reservation, and establish that the reservation is in the public interest. But frequently, as in the case of the Yellowstone River flow reservation case, total requested reservations far exceed a river's capacity and the reservation process does not guarantee all requests will be granted.

Although the MWPCA does not specifically address a policy of nongradation, the policy is implied:

> "The board shall require that any state waters, whose existing quality is higher than the established water quality standards, be maintained at that high quality unless it has been affirmatively demonstrated to the board that a change is justifiable as a result of necessary economic or social development and will not preclude present and anticipated use of these waters. [Section 69-4808.2 (1)(C)(ii), R.C.M.] 1947 ."

Further, nondegradation has been incorporated into the water quality standards [ARM16-2.14 (10)-S14480(6)]:

> General Water Quality Critera
>
> (a) The degree of waste treatment required to restore and maintain the standards is to be determined by the department and is to be based on the following:
>
> (1) The state's policy on nondegradation of existing high water quality...

Thus, a water quality standard defines a minimum level of water quality to be maintained or achieved and is not a justification for degradation.

Although a nondegradation policy is mandated by MWPCA and affirmed in the water quality standards, rules and standards for implementation of the policy have not been adopted by the Board of Health and Environmental Sciences (BHES) and so, DHES lacks the ability to fulfill its nondegradation duties.

The DHES's nongradation responsibilities are also complicated by similar responsibilities of another state agency, the Department of State Lands (DSL), under the Strip and Underground Mine Reclamation and Mine Siting Acts (Section 50-1034 et seq., R.C.M. 1947 and Section 50-1601 et seq., R.C.M. 1947. A nondegradation policy is proclaimed in the rules adopted to implement these Acts:

> "Nondegradation of waters. Waters within the public domain of the state that possess a higher quality than that established on the effective date of established standards shall be maintained at their present high quality consistent with the powers granted to the board. Such high quality waters shall not be lowered in quality unless and until it is affirmatively demonstrated to the board through public hearing, that such a change is justifiable as a result of necessary economic or social development and that the change will not adversely affect the present and future uses of such waters..." [ARM 26-2.10(10)-S10330(1)(a)].

> "Nondegradation of waters. Waters within the public domain that possess a quality higher than established standards shall be maintained at this present high quality consistent with the powers granted to the board." [ARM 26-2.10(18)-S10400(G)(3)(a)].

If pollutants decrease existing high quality, the nondegradation policy is violated and DSL is authorized to exercise its enforcement powers. Since DHES has statuatory jurisdiction over water quality, the DSL water quality rules may be unauthorized by virtue of being outside the scope of the Reclamation and Siting Acts; however, issues of conflicting and overlapping jurisdiction have yet to be raised.

## MANAGEMENT ALTERNATIVES

In view of Montana's existing regulatory framework for water quality management and the state and federal water quality goals, the Statewide 208 project presents the following management alternatives for consideration. One, all, or any combination of alternatives may be possible for a particular problem. Obviously, a viable alternative for all the problems is to maintain the status quo; however, the philosophy of the Statewide 208 project is to assume that if a problem is identified, it must be managed to some degree and at some point in time and so, the status quo alternative is not specifically addressed. However, in some cases, funding constraints and problem priorities may mean the status quo is maintained at least for a period of time.

Problem: <u>Agricultural Nonpoint Source Pollution of Surface and Ground Water and Stream Dewatering</u>

Alternatives:

1. Implement a nonregulatory water quality management program designating the Conservation Districts as the management agencies. Although such a program would ultimately deal with all water quality problems caused by agricultural activities, its primary initial objective would be sediment control. In many cases, if erosion is abated, salinity and dewatering impacts are also lessened. Major emphasis of the program would be to update Conservation District Long Range Plans to specifically include evaluation and management of water quality problems and to implement an active public education program.

2. Implement statewide Conservation District Ordinances similar to Lewis and Clark Conservation District Sediment Control Ordinance. The ordinance could require submittal of farm plans detailing necessary conservation measures and could provide enforcement capabilities to deal with violators.

3. Implement a statewide Sediment Control Law. Such a law would require legislative support but could be made broad enough to cover all sediment producing activities.

4. Recommend the BHES: (a) adopt rules to implement a nondegradation policy and standards to be applied in determining whether economic or social development will be allowed to degrade high quality waters and/or (b) make BMP's a specific part of the water quality standards.

5. Initiate a model Ag-NPS management demonstration project to to quantitatively document the effects of BMP's on water quality protection.

6. Initiate a statewide surface and ground-water monitoring network to document specific instances of Ag-NPS pollution and long-term impact trends and to more accurately quantify the extent of the problems.

7. Legislatively establish that water withdrawal applications should be evaluated for effects on water quality by DHES.

8. Initiate applications for flow reservations for water quality on at least some of the more valuable streams such as the Blue Ribbon segments.

9. Consolidate jurisdiction over water quality and withdrawals under one department.

10. Develop legislation to prohibit crop-fallow farming on saline seep-prone lands and to require immediate implementation of BMP's on lands suffering from saline seep.

11. Initiate a monitoring program in a priority basin, such as the Milk River Basin, to more accurately document the sediment and salinity impacts of irrigation return flows.

Problem: <u>Sediment From Urban Stormwater Runoff</u>

Alternatives:

1. Develop statewide guidelines to assist communities in predicting pollutant loadings and designing applicable structural and/or nonstructural management solutions.

2. Implement a nondegradation policy (discussed previously).

3. Develop new or modify exisiting city ordinances to specifically address stormwater runoff at least in priority cities.

Problem: <u>Sediment From Silvicultural Activities</u>

Alternatives:

1. Develop a State Forest Practices Act for approval by the legislature. The Act would deal with all silvicultural activities on state and private forest lands and require determination of potential water quality degradation prior to initiation of silvicultural activities.

2. Develop a Statewide Sediment Control Law (discussed previously).

3. Develop Conservation District Ordinances in forested areas. Districts have the statutory authority to regulate soil erosion through adoption of an ordinance by referendum vote. Such an ordinance could be made broad enough to deal with all sediment-producing activities or could be restricted to a single activities, such as silviculture, in those districts where the problem is particularly critical.

4. Implement a nondegradation policy and modify water quality standards to specifically address BMP's (discussed previously).

5. Develop a management agreement between DHES and the U. S. Forest Service. Major objectives would be to refine and expand USFS methodologies and priorities to deal more specifically with water quality protection and to develop a mechanism of continuous coordination between USFS and DHES.

6. Develop a state silviculture committee consisting of private, state, industrial, and federal forest owners. The group's major objective would be to implement joint land use planning to avoid independent and simultaneous silviculture activities in drainages with checkerboard ownership.

7. Assess and modify the state timber tax structure to prevent logging of private lands solely to reduce property taxes.

8. Support provision of additional funding and staffing to Division of Forestry for more comprehensive implementation of the Cooperative Management program.

9. Support hiring of an extension forester by the USDA Cooperative Extension Service for the purpose of intensifying public education and technical assistance.

Problem: <u>Ground-Water Contamination of Subdivisions</u>

Alternatives:

1. Develop more comprehensive statewide guidelines to facilitate selection of suitable subsurface disposal areas and installation of systems.

2. Modify or develop county regulations to control design, location, and installation of subsurface disposal systems. Such regulations could include zoning to prohibit development in high ground-water areas.

3. Develop ground-water quality standards to include subsurface impacts.

4. Develop a statewide ground-water monitoring network to document impacts of subsurface disposal systems.

Problem: <u>Acid Drainage and Sediment From Mining</u>

Alternatives:

1. Develop a Statewide Sediment Control Law (discussed previously).

2. Develop Conservation Sediment Control Ordinances in problem areas (discussed previously).

3. Implement a nondegradation policy and include BMP's in the water quality standards (discussed previously).

4. Recommend the Board of Land Commissioners adopt by rule the nondegradation in standards developed by BHES.

5. Establish a monitoring network to collect baseline data in drainages having significant potential for future mining development.

6. Develop ground-water quality regulations to control pollution.

7. Evaluate existing regulations for mining and exploration activities to determine their adequacy in protecting water quality and make appropriate modifications.

8. Develop an education program to provide small miners technical assistance on how to avoid water quality impacts.

9. Develop a special fund for correcting major existing mining problems by apportioning a small percentage of existing mining tax revenues or by placing an additional tax on mining operations.

10. Provide additional staffing to DHES or DSL to review and investigate specific mining and reclamation water quality problems.

11. Initiate a monitoring program to evaluate the adequacy of pollution control efforts on mine sites.

## PUBLIC PARTICIPATION

The Statewide 208 planning area includes 42 counties, 106,278 square miles and 437,000 people. The effort to stimulate and maintain continuous interaction between citizens and the planning staff (the goal of public participation) has proven to be challenging in such a large planning area with a relatively sparse population.

Steps taken by the Water Quality Bureau to encourage public participation in its 208 planning program include:

1. An advisory system, consisting of an advisory council and technical and citizens' information groups was organized. The function of the advisory system is to provide the 208 staff with program guidance, assist policy making and provide advice on public attitudes and technical management decisions.

2. Informational materials were distributed. Approximately 4,000 Statewide 208 pamphlets and 3,000 booklets on the state's water pollution control program were distributed to the public. A newsletter with a current mailing list of 520 has been distributed throughout the program period. And, fifteen different technical studies were distributed to the advisory system and general public.

3. Five-minute programs, explaining various aspects of 208 and water pollution problems were produced and distributed to local radio stations. Copies of the programs are available through the Water Quality Bureau. Interviews on two Montana radio stations and three television stations were made. One major article on 208 was widely publicized in the Montana Stockgrowers magazine Montana Farmers Stockman, Montana-Wyoming News, the Prairie Star and other smaller local newspapers. Public service announcements on stream bank, mining and dewatering problems were produced and aired on Montana television stations. Seven more television spots on rangeland, cropland, feedlots, salinity, erosion and subdivision development will be released before January, 1979.

4. Public involvement meetings were held in Butte, Anaconda, Dillon, Twin Bridges, Fairmont Hot Springs, Missoula, Sidney, Glendive, Plentywood, Malta, Great Falls and Lewistown. Additional meetings were conducted in conjunction with Institute of the Rockies water forums in Wolf Point, Glasgow, Missoula, Deborgia, and Great Falls. Presentations were given to Kiwanis Clubs, Granges, Conservation Districts and Council of Governments in many communities of Montana.

5. Visual aids (slide shows and films) were produced to aid public meetings and to reach the public through television. An excellent tape-slide series on water quality problems in Montana and a description of the 208 planning process as a problem-solving mechanism was developed. Two films were produced: One entitled Man and Water depicts the conflicts which arise between maintenance of instream flows and consumptive water uses; the other film, entitled Well Spring, discusses the purpose of the 208 planning program. Both films were shown on numerous occasions at 208 meetings. Also used was the NACD film, Non-Point '83.

6. Public meetings to obtain public input to the first draft of the Statewide 208 report will be held in October and November. These meetings are scheduled for Hamilton, Libby, Havre, Harlowton, Lewistown, Sidney, Plentywood, Helena, Libby and Havre.

A major objective of public meetings has been to receive citizen assistance in identifying critical water quality issues in their areas. The following are issues which were identified at the public workshops:

1. Southwestern Montana Area (Butte, Anaconda, Fairmont, and Twin Bridges)

    (a) Future use by the City of Anaconda of the Anaconda Company-owned Warm Springs treatment ponds for municipal wastewater treatment. The city does not want the expense of a sewage treatment plant if the existing ponds are adequate.

(b) Contamination of ground water and water supplies in the Opportunity subdivision area east of Anaconda from failing septic tanks and high ground-water conditions.

(c) Bacterial contamination of Blacktail Deer Creek from home sewage disposal systems located on the northeast side of Butte.

(d) Inadequate funding and staffing of 208 nonpoint source programs. Consequently, landowners fear they will be required to comply with regulations without sufficient financial or technical assistance causing them additional hardships. Uncertainty of funds to support NPS programs has also left considerable doubt as to the effectiveness of 208 programs in solving nonpoint source problems.

(e) Concern that water quantity-water quality problems will become more acute. Better program coordination between DNRC (Water Rights Bureau) and DHES (Water Quality Bureau) was felt to be needed to resolve conflicts. Also, limited water rights on unappropriated streams to protect instream values, improving enforcement of water rights and reservations by DNRC and speeding up water adjudication were all recognized as essential to resolving water use-water quality conflicts.

(f) Logging impacts. Regulating practices on forest watersheds (particularly private forest lands) was felt necessary if NPS water quality management programs are to be effective in non-woodland areas which are influenced by upstream forest management activites. People felt that since mining activities on private and federal lands are regulated, so should forest management activities be regulated.

(g) Adequacy of present mining laws (Open Cut and Hardrock Mining laws) is questionable. In particular, the seemingly inadequate enforcement capabilities and environmental protection provisions provided by the small miners exclusion were questioned. Opinions were expressed that more regulations would make mining unprofitable for the small miner; but, on the other hand, stronger environmental protection measures should be provided and their cost passed on to the consumer who would pay the true social cost for the product. A general feeling prevailed that increased mining potential in the area could adversely affect water quality given present capabilities of state agencies and inadequacies of environmental protection measures.

2. Sidney-Plentywood-Glendive

   General degradation of ground and surface waters from increasing saline seeps and oil and gas activity is a major concern. Frequent disposal of brine water on roads in borrow ditches and coulees was identified as a potential pollution source of local surface waters, and seemed to be the major local concern.

3. Great Falls Area

   (a) Clearly, the major problem of concern is the high sediment load in the lower Sun River caused by irrigation returns and erosion of Muddy Creek. Participants view the problem as correctable within certain limitations. Both recreational water users and agriculturalists see the need to correct the problem, but have expressed considerable disappointment in the "no follow-through action" by past government studies.

   Muddy Creek will be the yardstick for which local citizenry of this area measure the success of the 208 program. It represents a local problem of significant impact and one which can be corrected within certain limitations. Past efforts have failed because the problem has not had sufficient priority within the Bureau of Reclamation to warrant proper staff study or funding for planning and construction.

   (b) Dewatering on the Teton, Sun and Smith Rivers, salinity in the Teton River and Freezeout and Priests Butte Lakes, and mining effects in Belt and Sand Coulee Creeks were also listed as problems of concern. Solutions, however, were not as apparent as the Muddy Creek problem.

4. Missoula

   (a) Potential for contamination of the valley drinking water was a major concern. Rapid housing development in a valley characterized by heavy irrigation and high water tables associated with the flooding of outhouses, cesspools, septic tanks and drainfields is the cause for concern. City-county officials feel strongly that financial assistance from state or federal sources is needed to fund a study to better define the ground-water problems.

Public attitudes toward nonpoint source control programs have been difficult to ascertain. Meeting attendance, although exceptionally successful, was not truly representative of the general public. People in attendance mostly represented local, state or federal resource agencies and consequently nonpoint source control issues were expressed from a professional manager's point of view. This does not mean, however, that views among the group were unanimously consistent. Controversy, even among the professional group was apparent. Generally less than 10 percent of the

people attending meetings actually represented the "general public." However, for a few meetings such as at Great Falls and Lewistown, the majority of attendees represented the general public.

Most Montanans appreciate good water quality. However, at the same time, the average person's concepts of clean water and what affects its quality vary widely. The general concept of Best Management Practices is generally understood and accepted. Most people realize that more widespread use of farm management practices to control erosion would alleviate many water quality problems, even though elimination of erosion and sediment would never be completely realized. The major point of controversy was the cost-benefits that would be realized from specific practices and whether the practices should be encouraged voluntarily or through some level of regulatory process. In no way did any meeting approach resolving these points of controversy, even though healthy discussion was always the case.

Although BMP's seem to be intuitively accepted as the solution to NPS pollution, most people attending the meetings felt that BMP's should be cost-shared by the government because the practices would benefit the public (on a short-term basis) far more than the landowner. Whether implementation of BMP's is voluntary or regulatory, the consensus of opinion from the public meetings was that implementation would only be successful if adequate financial and technical assistance were provided. Adequate cost-sharing, better problem determination, definitive BMP's and increased education were felt to be essential to be an effective nonpoint source pollution control program.

Overall, the Statewide 208 public participation program has been moderately successful. A degree of public awareness of water quality issues has been achieved, but considering the size of the study area, still has a way to go. However, considering the program at the local level, it was most successful in stimulating public interest and involvement in southwestern Montana.

Certainly, there can never enough awareness and involvement by citizens and an active public participation program needs to be continued and expanded if 208 planning is to meet its objectives in Montana.

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